SCIENTIFIC AMERICAN SUPPLEMENT No. 740

Scientific American Supplement, Vol. XXIX. No. 740. Scientific American, established 1845.

NEW YORK, MARCH 8, 1890.

Scientific American Supplement, $5 a year. Scientific American and Supplement, $7 a year.

MR. STANLEY'S LATEST AFRICAN DISCOVERIES.

"THE MOUNTAINS OF THE MOON."

THE geographical discoveries made by Mr. H. M. Stanley's expedition in its route, accompanied by Emin Pasha, to the south of Lake Albert Nyanza, and west of Victoria Nyanza, through a region previously unexplored, are the latest additions to our knowledge of the wonderful interior of what has been called the "Dark Continent." They are of much scientific interest, apparently solving the question of the true source of the Upper White Nile, or rather of its western branch flowing through the Albert Nyanza—the eastern branch coming from the Victoria Nyanza—while they reveal also the position of the southern lake, hitherto vaguely spoken of as the "Muta Nzige," but henceforth named Lake Albert Edward Nyanza, in honor of the Prince of Wales. The land between the Albert Edward Nyanza and the Victoria Nyanza, with a central line from north to south about the 31st degree of east longitude, rises into lofty mountain ranges. A few of their high summits, which had been only seen at a distance by Mr. Stanley in December, 1887, and May, 1888, were then named Mount Gordon Bennett, Mount Edwin Arnold, and Mount Lawson; and these are marked in the map of Central Africa published by Messrs. W. & A. K. Johnston in 1888. In June last year, many months after his distant sight of those mountains from the southern extremity of Lake Albert Nyanza, Mr. Stanley, with his second in command, Lieutenant Stairs, R.E., the expedition having traveled southward through the Unyoro country, crossing the Semliki River, and approaching the mountains through the valley of Awamba, were enabled to gain a nearer acquaintance with this remarkable feature of a region hitherto unknown.

MR. H. M. STANLEY.
(A sketch from life, by Mr. Reginald Barratt, artist of the *Graphic*, at Cairo.)

Mr. Stanley's letter of August 17, 1889, to the Royal Geographical Society clearly describes the physical conformation of the vast trough, or subsidence of the earth's surface, 230 miles long, containing the Albert Edward Nyanza, with the plains on its shores, the Semliki River valley, and the Albert Nyanza; he also describes the Ruwenzori range of mountains, rising above the Semliki valley; and he considers them identical with what the ancients called "The Mountains of the Moon." This name is mentioned by Scheabeddin, an Arab geographer of the fifteenth century, who says that the Nile takes its rise from those mountains, a little south of the equator; which is now proved to be the fact, so far as the western branch of the Upper White Nile is concerned.

Lieutenant Stairs, the only member of the Emin Pasha Relief Expedition who actually ascended Ruwenzori to the height of 10,677 ft., on June 6, 1889, has favored us with the following comment or description:

"For centuries the sources of the Nile have been wrapped in mystery. Many attempts to reach the southernmost fountains have failed. We have been able to add a great deal to our knowledge of the Nile sources, and have

STANLEY'S ARRIVAL AT CAIRO.

discovered a range of mountains to the S.S.E. of the Albert Nyanza Lake, stretching away to the southward and westward, and then east again in a decidedly crescent-like form. The name given to the highest points of the range is Ruwenzori, though by different tribes it goes by different names.

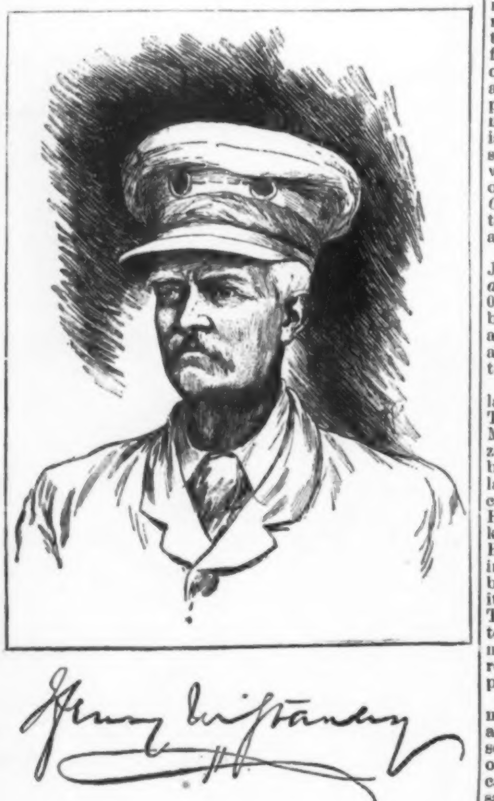
"The scenery afforded by these mountains, as one passes by their feet, is most splendid; deep valleys of an intense darkness run up from the forest beneath. A distinguishing feature of the range is the clear and well defined character of the hill tops; almost invariably on the southern side these are of a conical shape, with extremely steep slopes, some of them being quite 45 deg. in steepness. The lower spurs and gullies are covered with ordinary forest growth, up to a height of some 6,000 or 7,000 ft.; above this there is generally a forest of bamboo going up to 9,500 or 10,000 ft.; above this, again, for another 1,500 ft. of altitude, the hillsides are covered with tree heath, and all above this is bare rock and earth to the summits. A peculiarity to be observed in this range is the immense depth of the ravines or gullies between the spurs of the hills. Though the streams start from almost the summit, still they have very little fall, comparatively, as their channels appear to be cut right into the heart of the mountains; in some places the ravines down which these streams flow are quite 6,000 or 7,000 ft. deep. The height of the highest point of the range is about 17,000 ft., with about 2,000 ft. above the snow line.

"The country at the foot of the range is among the most fertile passed through by us. Bananas, Indian corn, beans, and matama are the chief products of the natives."

The position of Ruwenzori, as shown in Mr. E. G. Ravenstein's new map, "Stanley in Africa," published by Messrs. G. Philip & Son, is within less than one degree north of the equator, and in the thirtieth degree of east longitude. The mountain range to which it belongs, parallel with the Semliki River, which is the outlet of Lake Albert Edward Nyanza and the most southerly feeder of the Nile, extends in a southwest direction from a point of the Unyoro tableland opposite the south end of Lake Albert Nyanza, and is about ninety miles in length. It is remarkable that these mountains, nearly 18,000 ft. high, with snow-covered peaks, were not visible to Sir Samuel Baker, who supposed the Albert Nyanza to extend hundreds of miles farther south.—*Illustrated London News.*

HENRY M. STANLEY.

THE portrait on our first page is from a sketch made at Cairo for the *London Graphic* (weekly), and the smaller portrait is from the hand of another artist



made for the *Daily Graphic.* The *Times* correspondent gives the following life-like personal description of the great explorer: "Stanley stood on the quarter deck" (this was as the Kraptoria reached Suez) "dressed in gray tweed, his figure very much slighter than three years ago, his close-cut and almost perfectly white hair showing off his bronzed face, with its hard-set lips and cold gray eyes. He seemed the embodiment of physical endurance and mental self-control. I noticed a singular part resemblance to two men as different to himself as to each other—General Gordon and Captain Burton. He has the eyes of Gordon and the lips of Burton. There are times when Stanley's eyes have that far-away light which was the most striking characteristic of Gordon's personal appearance, and there are times when Stanley's lips make you feel that you would rather not quarrel with him."

Next day a special train brought Mr. Stanley and his party to Cairo. On the platform were Sir Evelyn and Lady Baring, Sir Francis and Lady Grenfell, and a very large gathering of many nationalities. Of all the gatherings of recent years at the Cairo Railway Station, perhaps the most striking was the arrival of the man who, three years ago, set off on his 5,000 mile tramp across Africa, and who, returning to meet an ovation, seemed to be mainly interested in the safety of his baggage. A carriage was waiting to convey him at once to the Khedive, and, during the half hour's interview which followed, Mr. Stanley appears to have succeeded in persuading his Highness that Emin Pasha, the former Governor of the Equatorial Provinces, would make an excellent civil administrator at Suakim. From the palace of the Khedive Mr. Stanley went at once to Shepherd's hotel—*the* hotel of Cairo—and his entrance there is depicted in another of the *Graphic* sketches which we give.

STAR DISTANCES.*

THE festal offering contributed by Prof. Oudemans to the Pulkowa celebration is an especially appropriate one. The incidents of the long parallax campaign can scarcely be recapitulated without recalling, in connection with the name of Friedrich Struve, the *quorum pars magna fui* of Æneas. He it was who, in Sir John Herschel's opinion (Memoirs R. Astronomical Society, vol. xii., p. 442), made the first real impression upon the problem by showing that not one of twenty-seven circum-polar stars discussed in 1819-21 could possibly have an annual parallax amounting to half a second of arc. Thenceforward, astronomers knew what they had to expect. Sanguine hopes of meeting comfortably large, and properly periodical, residuals among ordinary observations were checked, if not extinguished. The changes of stellar position reproducing, according to the laws of perspective, the movement of the earth in its orbit, were perceived to be on a scale so minute that their satisfactory disclosure lay, for the moment, beyond the range of what was feasible. Success in the enterprise, it was evident, was conditional upon the employment of more perfect instruments than had heretofore been available, with a precision and vigilance of which the very idea was absent from all but a few prescient minds. Sir William Herschel seemed to have anticipated the conjuncture when he declared in 1782 the case to be "by no means desperate," although stellar parallax should fall short of a single second (*Phil. Trans.*, vol. lxxii., p. 83). The memorable "triple event," by which, almost simultaneously, at the Cape, at Konigsberg, and at Pulkowa, his confidence was justified, is familiar to all readers of astronomical history. Its significance may be estimated from Bessel's admission that, until the yearly oscillations of 61 Cygni emerged from his measures in 1838, he was completely in the dark as to whether stellar parallax was to be reckoned by tenths or by thousandths of a second (*Astr. Nach.*, No. 385).

The value to students of Prof. Oudemans' synoptical view of what has since then been achieved in this direction can hardly be overstated. Not only does he record every individual result worth considering, but the tabulated particulars enable a fair judgment to be formed as to the value of each. There are, indeed, one or two cases in which a note of warning might with advantage have been added. Thus Dr. Brunnow's small parallax for 85 Pegasi, to say the least, requires confirmation. A perfect *equability* in the mode of observing is essential in such delicate operations; but the Dunsink astronomer was himself conscious of, and noted with his usual care, a slight change, as the series flowed on, in his habit of "bisecting" the large star (*Dunsink Observations*, vol. ii., p. 38). The distance of this interesting binary system can hence scarcely be regarded as even approximately known.

Still less reliable, though for different reasons, are Johnson's measures of Castor and Captain Jacob's of α Herculis. The parallax assigned to the latter star of 0"·062 relative to its fifth magnitude companion cannot be other than illusory, since the pair, as evidenced by a small but well ascertained common proper motion, are physically connected, and must therefore be at virtually the same distance from the earth.

Forty-nine stars, all save one measured within the last sixty days, are included in Prof. Oudemans' list. The exception deserves particular mention. Samuel Molyneux erected at his house in Kew Green, in 1725, a zenith sector by Graham, with which he began, in combination with Bradley, a set of observations for parallax on γ Draconis. The same star had, in the previous century, been similarly experimented upon by Robert Hooke with something of a dubious success. The well known eventual issue of Molyneux's observations was Bradley's discovery of the aberration of light; but they included besides an element of true parallactic change, brought out by Dr. Auwers' discussion in 1869,† after it had lain concealed among them for 142 years. The eye and hand must indeed have been faithful thus to record an ebb and flow of change profoundly submerged, at that comparatively remote epoch, in the reigning confusion between the real and the apparent places of the heavenly bodies.

A light journey of sixty-five years (parallax=0"·05) may be considered the present limit of really measurable stellar distance. Forty of the forty-nine objects so far investigated lie—most of them certainly, a few only probably—within it. Forty stars can thus be located with some definiteness in space—forty among, say, forty millions! The disproportion between our knowledge on the point and our ignorance is so exorbitant that general conclusions seem discredited beforehand, and negative ones at any rate can have no weight whatever. Nevertheless, one remark at least is fully warranted by the evidence.

It is this, that the largest stars are not always those nearest to the earth. For to the narrow category of stars at ascertained distances belong no less than seven invisible to the naked eye, one of them in closer vicinity to us than Sirius, all than Capella, Vega, Arcturus, or Canopus. A cursory view might almost suggest—irrespective of geometrical possibilities—that stellar brightness had nothing whatever to do with remoteness. The legitimate and certain conclusion to be derived from the facts, however, is that the disparities of stellar light power are enormous. A farthing rushlight is not more insignificant compared with the electric arc than a faint compared with a potent sun. Sirius emits 6,400 times as much light as a ninth magnitude star north of Charles' Wain (Argelander-Oeltzen 11,677); our own sun falls nearly as far short of the radiative strength of Arcturus. Inequalities of the same order between the members of revolving systems emphasize this result. Sirius shines like four thousand of its own companions; and the movements of other stars are perhaps swayed by almost totally obscure bodies.

The inference that the apparent luster of individual stars tells us nothing as regards their distance was already drawn by Dr. Huggins in 1866 (*Phil. Trans.*, vol. clvi., p. 393); it has been amply confirmed since, and cannot be too forcibly insisted upon. We are unable to place either an upper or a lower limit to stellar dimensions or intrinsic emissive intensity. Until Arcturus was proved to be immeasurably remote, few would have been disposed to credit the existence of a sun in space at least six thousand times as effulgent as ours is; but we know no reason why Arcturus itself should not be as vastly exceeded by some giant orb at the outskirts of the Milky Way; while we are equally debarred from asserting that among sixth, seventh, twelfth magnitude stars, there may not be found some minute bodies at half the distance from us of α Centauri.

But when we pass from particular to general reasoning, the aspect of the matter changes. No cause has yet been shown why the stars should be exempt from obedience to the "law of large numbers," which provides (as Prof. Edgeworth has ably shown) a clew to other labyrinths of facts. Statistics, it is true, are often misleading, but only when they are wrongly employed. The frequent misuse of a method does not justify its total rejection. And the statistical method is peculiarly liable to misuse. Attempts to get from it more than it will properly give inevitably fail; and what it will properly give are general statements which should only be generally applied. An average result may not be the less instructive because it is by its nature incapable of furnishing specific data.

The stars then *must*, on the whole, decrease in brightness as their distances increase, and they must do so according to an underlying fixed law which will be more and more closely conformed to, the larger the number of instances included in the generalization. Each descent of one stellar magnitude represents a falling off in light in the proportion of 2½ to 1; it represents, accordingly, an augmentation of distance in the proportion of the square root of 2½, or 1·59 to 1. Theoretically, that is to say, stars of any given magnitude are 1·59 times more remote than those one magnitude superior, 2½ times (1·59 × 1·59) where the gap is of two magnitudes, and so on. This would be strictly and specifically true if all the stars were equal; but since they are enormously unequal, the rule may be grossly misleading in particular instances, and can only, by taking wide averages, be brought to approximate closely to actual fact.

The determination of individual parallaxes has always, with astronomical thinkers, been subordinate to the higher aim of obtaining a unit of measurement for sidereal space. Hence continual attempts to fix the "average parallaxes" of classes of stars, which, however, remained futile so long as precarious assumptions supplied the place of direct information. Nor could this be obtained until the exigences of the research had evoked improved means of practically meeting them. The earlier observers chose the subjects of their experiments entirely with a view to their successful issue. Stars likely, owing to their brilliancy, their swift motion, or both combined, to be nearer the earth than most others were picked out for measurement, with results each by itself of high interest, but worthless for generalizing purposes. It is only a few years since increased skill in the handling of methods authorized an extension of the range of their application. The first systematic plan for investigating "mean parallax" was proposed by Dr. Gill in 1883, and is now in course of combined execution at Yale College and the Cape. The completion last year of a section of the work enabled Dr. Elkin to deduce an average distance of thirty-eight light years for the ten first magnitude stars of the northern hemisphere; but it would of course be folly to regard this avowedly "provisional and partial" result as a satisfactory basis for definitive conclusions about the distances of more remote classes of stars. At the most, it makes a useful temporary starting point for some trial trips of thought through space. Before long, however, through the exertions of Dr. Gill and Prof. Pritchard, direct measures, not only of all the first, but of most of the second magnitude stars all over the sky, will have been executed; and the proportion between distance and brightness thus established may with some confidence be used as a fathom line for sounding otherwise inaccessible sidereal abysses.

A. M. CLERKE.

* "Uebersicht der in den letzten 60 Jahren ausgefuhrten Bestimmungen von Fixstern parallaxen." Von J. A. C. Oudemans. Eine Festgabe zum 50 jahrigen Jubilaum der Sternwarte zu Pulkowa. *Astronomische Nachrichten*, Nos. 2915-16.—*Nature.*

† *Monatsberichte*, Berlin, 1869, p. 630. The result places γ Draconis at a distance of 35⅙ light years, but with a very large "probable error" (parallax=0"·092 ± 0"·070).

THE GROWTH OF TREES.

EVERY one who knows anything about trees is familiar with the fact that although the heart of the tree is surrounded by the rings that are formed annually, the heart is not necessarily, nor indeed frequently, the center of the bole, or, in other words, that while on one side the rings are so close that they can hardly be counted, they may on another side be a considerable distance apart. While this fact is patent to all, the cause of it is by no means universally understood. Perhaps the theory most generally accepted is that the widest rings are formed on the side of the tree facing the south, while there is another theory held by a few persons, viz., that the greatest enlargement will usually be found toward the east. There is still another class who assure us that the greatest extension will be found on the side where the tree has most room. Now, I would humbly venture to suggest that none of all these theories is correct, and that the widest rings will invariably be found on the side where the tree has made the most vigorous roots.

This direction is determined, not by any greater inherent vigor in certain roots when the tree was planted, but simply by the nature of the soil, the roots being most strongly developed toward the richest feeding ground. I saw this strikingly exemplified lately in a wood where a large number of old trees were lying as they had been blown down and cross-cut. These comprised both firs and hardwood trees. A silver fir which had been growing pretty close to the south boundary wall had a radius of two feet toward the north, the soil being rich and easily penetrated in that direction;

whereas on the south side toward the wall, where the soil was hard and stony, the roots had found little encouragement to extend, and the radius only measured one foot. Then in the case of a beech that had been planted close to a road, the strong roots and wide rings were found on the opposite side from the road in a northwesterly direction. In the center of the wood, where the soil was similar all round, vigorous roots were found to have pushed equally on all sides, and in these trees the heart was always found to be the center of the bole. It is a noticeable fact that the branches or limbs of trees have the wide rings always on the under side. This, I fancy, may be explained by the sap finding freer access in that direction, and perhaps the greater tension of the vessels on the upper side may have a constricting effect on them.

Seeing that in slit planting the roots are not spread out as in pit planting, but are drawn in a particular direction, might it not be well to let that be facing the prevailing wind? This would involve no extra expense, and where the soil is of the same character all round, the roots would naturally take the earliest and firmest hold in the direction given them. Let any one plant a young tree, or if he prefers it sow a seed, and let the soil on one side be retentive clay or gravel, and the other side made up of rich friable loam into which the roots will freely penetrate. When he cuts down the tree after a given number of years, he will find that on the side on which the roots have been feeding in the fertile soil the tree will have laid on double the quantity of timber, measuring from the heart, that it has made on the barren side. If this is not conclusive proof that the soil has a good deal to do with the final shaping of the trunk, I do not know what would be accepted as such.—*J., in The Garden.*

[FROM THE AMERICAN LAW REVIEW.]

SURFACE WATERS.*

4. ENGLISH RULE.—In view of the very decided doctrine adopted by Massachusetts and now generally spoken of as the common law rule, it becomes a matter of interest to ascertain the law contained in the English decisions. This question acquires additional importance in view of the fact that many of the Western States have statutory or constitutional provisions which require the courts to follow the common law of England. Thus in Arkansas, the court declared that with regard to the decisions which followed the civil law rule "so far as they proceed upon the adoption by the courts of the civil law doctrine as the more reasonable one, we feel precluded by our statute from accepting them as authority."[78]

The courts which have adopted the so-called common law rule have applied to surface waters the remark of Lord Tenterden that water is a common enemy against which each proprietor must defend himself.[79] This remark, however, was not applied to surface waters, and can constitute no authority for the common law rule.[80]

An examination of the English decisions shows that the question whether the lower proprietor is entitled to obstruct the flow of surface waters, and thereby dam it back upon the higher lands, has never been before the courts. In other words, it is still undecided whether the lower proprietor is or is not subject to a natural easement or servitude to receive surface waters naturally flowing upon his lands. The cases of Chasemore v. Richards,[81] Acton v. Blundell,[82] Rawstron v. Taylor,[83] and Broadbent v. Rowbotham,[84] are the leading English cases upon the law of surface waters, but they are all cases where the plaintiff complained of the act of the defendant in appropriating the water, and contain nothing either by way of inference or *dicta obiter* which can be construed as authority for the proposition that the lower proprietor is at liberty to reject the surface waters if he so pleases. The cases of Wilson v. Waddell,[85] Baird v. Williamson,[86] and Smith v. Kenrick,[87] are authority for the proposition that a mine owner, whose mine is on the rise, is entitled to work and win the whole minerals in the usual way—such being the natural use of the property—and is not bound to leave any barrier to prevent the flow of surface waters into a neighboring mine which is on the dip. The courts hold that the owner of the lower mine has no cause of action against the owner of the higher and that he must protect himself by leaving a barrier of mineral to prevent the flow. These cases do not constitute an authority for the proposition that the lower proprietor may obstruct the flow of surface water, nor on the other hand are they authority for saying that his lands are burdened with the servitude of receiving the waters. They simply hold that the higher mine owner having put his lands to their natural use without any negligent act or malice on his part, the lower proprietor cannot complain if his property has, in consequence, been exposed to a flow of water. Except the case of Smith v. Kenrick,[88] none of the cases contain any *dicta* upon the point under consideration. In that case Cresswell, J., who delivered the opinion of the court, declared that a holding that the lower proprietor had no cause of action was "in accordance with the civil law, by which it was considered that land on a lower level owed a natural servitude to that on a higher, in respect of receiving, without claim to compensation, the water naturally flowing down to it."

In the subsequent case of Hurdman v. Northeastern Ry. Co., the plaintiff alleged that the surface of the defendant's lands had been artificially raised by earth placed thereon, and that in consequence water falling on the defendant's land made its way through the wall into the adjoining house of the plaintiff, and caused substantial damage. The court held that the heap or mound being artificial, the plaintiff had showed a cause of action. With reference to the mining cases above referred to, Cotton, L. J., who delivered the opinion of the court, says: "It is urged that this is at variance with the decision that if, in consequence of a mine owner on the rise working out his minerals, water comes by natural gravitation into the mines of the owner on the dip, the latter owner cannot maintain an action for the loss which he thereby sustained. But excavating and raising minerals is considered the natural use of mineral land, and these decisions are referable to this principle, that the owner of land holds his right to the enjoyment thereof subject to such annoyance as is the consequence of what is called the natural user by his neighbor of his land, and that when an interference with this enjoyment by something in the nature of a nuisance (as distinguished from an interruption or disturbance of an easement or right of property in ancient lights, or the support of the surface to which every owner is entitled) is the cause of complaint, no action can be maintained if this is the result of natural user by a neighbor of his land." The whole opinion shows that the controlling reasons of the decision were that the defendant had a right to the reasonable enjoyment of his property, but limited by the maxim, *Sic utero tuo, ut alienum non lædas.*

Applying this reasoning to the English decisions, it follows that as mining is the natural use for mining property, and agriculture for arable lands, in the case of arable lands the upper proprietor might drain his lands in the usual course of husbandry without exposing himself to an action by the lower proprietor, and the latter, on the other hand, could not interfere with the drainage, except such interference be necessary to the reasonable use of his property. The application of this principle would thus indicate that in the light of present decisions, the law in England closely resembles the modified doctrine adopted in Arkansas.

The important point is, however, that it, at present, does not in the slightest resemble the so-called common law rule adopted by Massachusetts, New York, and other States, which is based upon an application of the maxim, *Cujus est solum, ejus est usque ad cœlum.* In view of the fact that there is not, and never has been, any law in England which will support the Massachusetts doctrine, it is difficult to see how it can be justified, and certainly it can have no claim to the name so commonly applied to it.[90]

VIII. DRAINAGE OF SURFACE WATERS.—In all the States, without any distinction, it is held that the upper proprietor cannot collect the surface waters upon his lands into a body and discharge it through a ditch or drain upon the lands of the lower owner,[91] or upon lands where they would not otherwise go.[92] It has been held that against an invasion of the rights of a lower proprietor by casting in a body upon his land to his injury the surface waters of the superior estate, the lower proprietor may defend himself by placing obstructions in the drain or channel, if he thereby does not inflict injury upon innocent strangers; and it is to be noticed that this decision was given by a court which has adopted the doctrine of the civil law.[93] The upper proprietor may, however, in the exercise of his right to the reasonable enjoyment of his lands, drain surface waters into a stream into which they would naturally flow, although the result may be to increase materially the volume of water flowing through the lands of the lower riparian owners,[94] but he cannot drain into the stream waters upon lands of which it does not form the natural drainage;[95] and the right to drain into the stream is subject to the further limitation that the volume of water must not be increased beyond the natural capacity of the water course to discharge it, and that the land of an adjoining owner is not thereby overflowed and materially injured.[96]

In those States in which the civil law servitude has been adopted, the owner of the upper estate may make drainage works which are necessary to the proper cultivation and development of his estate. To that end he may cut ditches and lay drains, by which the flow of the surface waters upon his estate may be increased beyond the slow process by which they would ultimately reach the same destination.[97] But this right cannot be used by the upper proprietor for the purpose of reclaiming swamps and marshes, and must be confined to the natural development of agriculture.[98]

In Indiana, a State in which the rule of the common law has been adopted, and in which, therefore, there is no natural servitude, the court in one case declared that the owners of the higher lands might make such drains as are required by good husbandry and the proper management of the surface of the ground, without being liable to any action at the instance of the lower proprietor,[99] but in a subsequent case the court laid down the rule that he either must keep surface waters within his boundaries or permit them to flow off without artificial interference, unless within the limits of his lands he can turn them into a natural water course.[100]

In New York, where the common law rule is also followed, it has been held that so long as the land owner only does upon his own premises whatsoever is necessary to enable him to have the natural use of his land, or, in any use he may make of it, does not injure his neighbor, no ground arises for the interference of the court. Accordingly, where a land owner plows his land so as to leave a dead furrow at the bottom of a depression, for the purpose of permitting the surface water more readily to escape, and the flow is thereby accelerated, the lower proprietor has no cause of action.[101]

An owner of land has no right at common law to the support of subterranean water, and if his neighbor drains his land and thereby causes the subsidence of the adjoining property, no right of action arises.[102]

IX. POLLUTION OF SURFACE AND PERCOLATING WATERS.—If any man bring filth upon his lands, he must keep it within bounds, so that it does not injure his neighbor.[103] Accordingly, a proprietor who allows obnoxious substances to escape from his premises and contaminate a neighbor's well, is liable to an action therefor.[104] He may also be sued, although the filth is allowed to flow some distance over the surface of the ground, and then to fall into and pollute a water course.[105] In England, an injunction was granted in a case in which the defendant, who owned a worsted mill near plaintiff's property, allowed noxious and offensive refuse water to flow from his mill into an old pit on his own land, whence it percolated underground to plaintiff's colliery, and injured the health of his employes.[106] Gas companies have been held answerable for the corruption of adjoining lands and wells thereon, by the fluids percolating from the works;[107] and if it can be clearly proved that a place of sepulture is so situated that the burial of the dead there will endanger life and health, by corrupting the water of wells or springs, relief may be obtained.[108] But in one case, relief was refused when it appeared that the plaintiff had voluntarily bought and located his residence in the immediate vicinity of a burying ground which the defendants were merely proposing to enlarge without bringing it nearer, and that his barn yard was nearer the well and more likely to injure it than the burying ground.[109]

J. C. THOMSON.

Albany, N. Y.

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* Continued from SUPPLEMENT, No. 739, page 11801.

[78] Little Rock & S. F. R. Co. v. Chapman, 39 Ark. 463; *s. c.* 43 Am. Rep. 280.

[79] The remark of Lord Tenterden has been very extensively misapplied. It was originally made in Rex v. Com'rs of Sewers of Pagham, 8 B. & C. 355, 360. That case did not, as might be inferred from American judges and writers, apply to surface water at all. The extent to which the idea that surface water is a common enemy, which each must fight for himself, prevails can only be appreciated by an examination of the cases. The following are a few of those in which the reference occurs: Cairo & V. R. Co. v. Stephens, 73 Ind. 278; Livingston v. McDonald, 21 Iowa, 160, 174; Benson v. Chicago, & A. R. Co., 78 Mo. 504; Shane v. Kansas City, St. J. & C. B. R. Co., 60 Mo. 329; McCormick v. Kansas City, St. J. & C. B. R. Co., 57 Mo. 433; West Orange v. Field, 37 N. J. Eq. 600. See also 2 Dillonous Mun. Corp. (2d ed.), sec. 1039. In the case in which the remark was first made the commissioners of sewers had e ected certain works to prevent encroachment by the sea. The result was that the force of the water was directed against another part of the coast. The action was brought by way of rule to show cause why *mandamus* should not issue to compel the commissioners to have damages assessed or to erect further works. Lord Tenterden said (p. 360): "The sea is a common enemy to all proprietors on that part of the coast," and again (p. 361): "I am of opinion that the only safe rule to lay down is this, that each land owner for himself may erect such defenses for the land under his care as the necessity of the case requires, leaving it to others, in like manner, to protect themselves against the common enemy." There is great appropriateness in the original application of the term, for there the sea was encroaching upon the land. The appropriateness of the expression is lost to a great extent when applied to surface waters. They might be much more fitly denominated a common nuisance.

[80] See Rex. v. Com'rs of Sewers for Pagham, *supra.*

[81] 7 H. L. 349.

[82] 12 M. & W. 352.

[83] 11 Exch. 369.

[84] 11 Exch. 602.

[85] L. R. 2 App. Cas. 95. This was an appeal from a decision of the Scotch Court of Session. It may be mentioned that in Scotland, where the civil law is closely followed, the flow of water in adjoining mines is governed by the same rules as the flow of surface waters. "There can be no doubt, on the one hand, that the owner of a mine is entitled to work out the minerals without regard to the interest of his neighbor, so long as he confines his operations to his own grounds and resorts to no extraordinary means of working; and if the effect of working out these minerals be to throw water down upon his neighbor, who lies upon a lower level than himself, that is just the natural servitude which the lower heritor below ground must submit to, as the lower heritor above ground does; and on the other hand, the lower heritor, if he desires to protect himself against the invasion of water from above, must secure that protection by leaving a sufficient barrier of his own minerals upon the march to prevent the water finding its way to him." L. P. Inglis in Durham v. Hood, 9 Sc. Ses. Cas. 3d Ser., 474, 479.

[86] 15 C. B. (N. S.) 376.

[87] 7 C. B. 515.

[88] 7 C. B. 515, 564.

[89] L. R. 3 C. P. Div. 168.

[90] This question is very fully discussed in Boyd v. Conklin, 54 Mich. 583; *s. c.* 52 Am. Rep. 831. In that case it was held that the servitude in favor of the upper lands did exist. The court said: "It is urged strenuously on plaintiff's behalf that there is a radical difference between the common and the civil law upon the subject of the relations of upper and lower estates as to water easements and servitudes, and that at common law the latter owes no service to the former in regard to the flow of surface water. As we are not expected to be experts in the civil law, we shall not attempt to discuss that department of jurisprudence as a separate subject. But it so happens that from the time of Bracton down, attention has been frequently called by the common law courts to the fact that the whole subject of rights in water has been defined by the civil law writers in terms which substantially agree with the recognized rules of the common law, and that they agree very closely, not necessarily because one has been borrowed from the other, but rather because both are naturally drawn from the general usages and necessities of mankind. . . . As previously suggested, the rights of upper and lower owners are not treated by the common law authorities as peculiar to either common or civil law, but as natural incidents to the land, which are and must be analogous as governed by universal jurisprudence, except where specially modified. The English courts have never hesitated to cite the civilians on such questions, and they have decided cases arising out of England without attempting to inquire into any local law as the basis of decision."

[91] *Common Law States.*—Cairo & V. R. Co. Stevens, 73 Ind. 278; Templeton v. Voshloe, 72 Ind. 134 *s. c.* 37 Am. Rep. 150; Rathke v. Gardner, 134 Mass. 14; Curtis v. Eastern R. Co., 98 Mass. 428; *s. c.* 96 Mass. (14 Allen) 55; White v. Chapin, 94 Mass. (12 Allen) 516; Benson v. Chicago, & A. R. Co., 78 Mo. 504; McCormick v. Kansas City, St. J. & C. B. R. Co. 70 Mo. 359; *s. c.* 35 Am. Rep. 431; Kelly v. Dunning, 39 N. J. Eq. 118; Barkley v. Wilcox, 86 N. Y. 140, 147; Noonan v. City of Albany, 79 N. Y. 470; Mitchell v. New York, L. E. & W. R. Co., 36 Hun, (N. Y.) 177; Foot v. Bronson, 4 Lans. (N. Y.) 47; Saal v. Abeles, 20 N. Y. Weekly Dig. 528; Pettigrew v. Village of Evansville, 25 Wis. 223; *s. c.* 3 Am. Rep. 50.

Civil Law States.—Crabtree v. Baker, 75 Ala. 91; *s. c.* 51 Am. Rep. 424; Hughes v. Anderson, 68 Ala. 280; *s. c.* 44 Am. Rep. 147; Goldsmith v. Elsas, 53 Ga. 186; Peck v. Herrington, 109 Ill. 611; *s. c.* 50 Am. Rep. 627; Hicks v. Silliman, 93 Ill. 255; City of Aurora v. Reed, 57 Ill. 29; *s. c.* 11 Am. Rep. 1; Livingston v. McDonald, 21 Iowa, 160; Ludeling v. Stubbs, 34 La. Ann. 935; Guesnard v. Bird, 33 La. Ann. 796; Sowers v. Shiff, 15 La. Ann. 300; Martin v. Jett, 22 La. 503; Butler v. Peck, 16 Ohio St. 334; Miller v. Laubach, 47 Pa. St. 154; Kauffman v. Griesemer, 26 Pa. St. 407; Knight v. Brown, 25 W. Va. 808; Gillison v. Charleston, 16 W. Va. 282.

States in which question undecided.—Davis v. Londgreen, 8 Neb. 43. See also Amick v. Tharp, 13 Gratt. (Va.) 564, where it was held that a land owner, even though waters be discharged on his premises by another unlawfully, cannot obstruct or divert the flow if the result is to throw the water upon the lands of a third person where they would not otherwise go.

[92] Hughes v. Anderson, 68 Ala. 280; Hogenson v. St. Paul, M. & M. Ry. Co., 31 Minn. 224; Butler v. Peck, 16 Ohio St. 334; Amick v. Tharp, 13 Gratt. (Va.) 564.

[93] Crabtree v. Baker, 75 Ala. 91; *s. c.* 51 Am. Rep. 424.

[94] Peck v. Herrington, 109 Ill. 611; *s. c.* 50 Am. Rep. 627; Cairo & V. R. Co. v. Stevens, 73 Ind. 278; Templeton v. Voshloe, 72 Ind. 134; *s. c.* 37 Am. Rep. 150; Jackman v. Arlington Mills, 137 Mass. 277; Treat v. Bates, 27 Mich. 390; McCormick v. Horan, 81 N. Y. 86; *s. c.* 37 Am. Rep. 479; Waffle v. N. Y. Central R. Co., 53 N. Y. 11; *s. c.* 13 Am. Rep. 467; Foot v. Bronson, 4 Lans. (N. Y.) 47; Miller v. Laubach, 47 Pa. St. 154; Knight v. Brown, 25 W. V. 808; Gillison v. Charleston, 16 W. Va. 282.

[95] Waffle v. N. Y. Central R. Co., 53 N. Y. 11; *s. c.* 13 Am. Rep. 467.

[96] Jackman v. Arlington Mills, 137 Mass. 277; McCormick v. Horan, 81 N. Y. 86; *s. c.* 37 Am. Rep. 479; Noonan v. City of Albany, 79 N. Y. 470.

[97] Hughes v. Anderson, 68 Ala. 280; *s. c.* 44 Am. Rep. 147; Peck v. Herrington, 109 Ill. 611; *s. c.* 50 Am. Rep. 627; Hicks v. Silliman, 93 Ill. 255; Livingston v. McDonald, 21 Iowa, 160; Ludeling v. Stubbs, 34 La. Ann. 935; Sowers v. Shiff, 15 La. Ann. 300; Martin v. Jett, 12 La. 501; Kauffman v. Griesemer, 26 Pa. St. 407; Martin v. Riddle, 26 Pa. St. 415.

[98] Ludeling v. Stubbs, 34 La. Ann. 935; Sowers v. Shiff, 15 La. Ann. 300.

[99] Templeton v. Voshloe, 72 Ind. 134.

[100] Cairo & V. R. Co. v. Stevens, 73 Ind. 278.

[101] Peck v. Goodberlett, 109 N. Y. 180.

[102] Popplewell v. Hodkinson, L. R. 4 Exch. 248. Also, Smith v. Thackerah, L. R. 1 C. P. 564.

[103] Tenant v, Golding, 2 Ld. Raym. 1089; Salk. 21, 360; 6 Mod. 311; Holt, 500. See also Marshall v. Cohen, 44 Ga. 489; Ballard v. Tomlinson, L. R. 29 Ch. Div. 119.

[104] Wahle v. Reinbach, 76 Ill. 322; Ottawa Gaslight and Coke Co. v. Graham, 35 Ill. 346; Ball v. Nye, 99 Mass. 582; Sherman v. Fall River Iron Works Co. 87 Mass. (5 Allen) 213; Wormersley v. Church, 17 L. T. (N. S.) 190. See, also, Sate v. Parrish, 7 T. B. Monroe (Ky.), 325; Turner v. Mirfield, 34 Beav. 390.

[105] Hodgkinson v. Ennoy, 4 B. & S. 229.

[106] Turner v. Mirfield, 34 Beav. 390. See also Ballard v. Tomlinson, L. R. 29 Ch. Div. 119.

[107] Pottstown Gas Co. v. Murphy, 39 Pa. St. 257. See also Columbus Gas Light & Coke Co. v. Freeland, 12 Ohio St. 392.

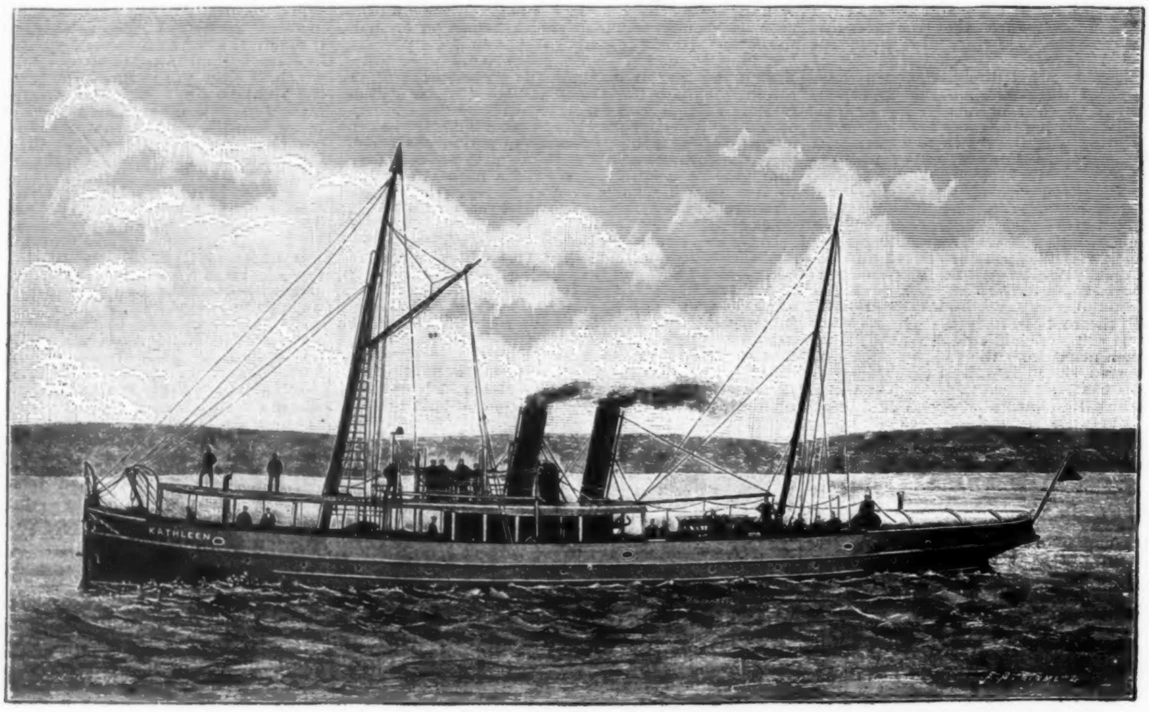
[108] Clark v. Lawrence, 6 Jones (N. C.) Eq. 82.

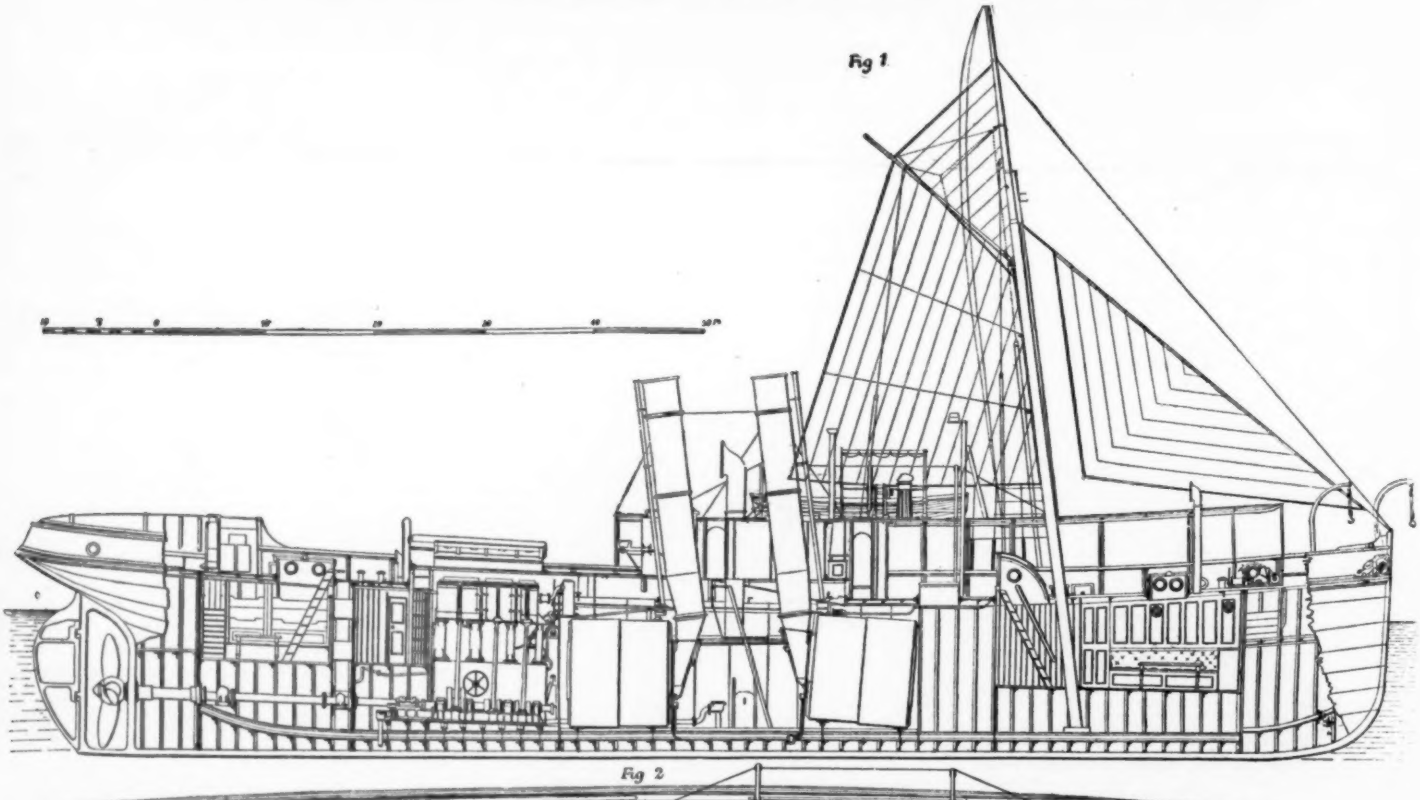
[109] Upjohn v. Twp. of Richland, 46 Mich. 542.

THE SCREW TUG KATHLEEN.

WE illustrate the steel screw tugboat Kathleen, built and engined by Messrs. Cox & Co., of the Docks Iron Works, Falmouth.

The Kathleen is 120 ft. long between perpendiculars by 20 ft. beam and 14 ft. deep, and is the largest and most powerful tug yet built in the West of England.





THE SCREW TUG KATHLEEN.

The scantlings are in excess of Lloyd's requirements for the highest class. An awning or shade deck extends for about sixty feet of the vessel's length, and a turtle-back is fitted over the stern for the accommodation of the native crew, the vessel being expressly built for Indian service.

Coal bunkers are placed on either side of the boilers, and a cross bunker forward of the fore boiler. When coal is burned down, the vessel is trimmed by a ballast tank placed forward. All the details of arrangement are most complete for a vessel of this class, and include Clark, Chapman, Parsons & Co.'s patent steam windlass.

The engines are of the triple expansion type, with cylinders 16 in., 26 in., and 43 in. in diameter and 28 in. stroke, and are fitted with Sisson's patent valve gear, which has the usual advantages over ordinary link motion claimed by gears of this class; there are also no sliding working parts, and throughout the gear is adjustable.

The vessel's first run (of forty-seven days) was to Rangoon, and at the end of this period the gear did not require overhauling. Steam is supplied at 150 lb. working pressure from two large horizontal return-tube boilers, each being fitted with two of Fox's patent corrugated flues. On the trial trip the engines gave out an indicated horse power of 600, and the speed attained by the vessel was 12 knots.—*Engineering.*

THE STANLEY CYCLE SHOW.

THE thirteenth annual exhibition of cycles and accessories, known as the Stanley show, was opened at the Crystal Palace, London, on the 24th January, and closed on the 1st February. The show was first held last year at the Crystal Palace, and was very successful, and this year the number of exhibitors has grown from 185 to 200. Two-thirds consist of the "safety" or geared-up bicycle type, and the remainder are tandems, bicycles and tricycles for two riders, twin bicycles, tricycles, and ordinary bicycles. The last named type is coming back into partial favor again, as it is now made with a larger back wheel, and with the saddle placed farther back from the handles, thus giving greater security to the rider. Diamond shaped frames and half diamond frames appear to be coming into general favor. Attention is being given to the

middle-aged rider by the introduction of a joint in the frame and springs to diminish vibration, and several makers exhibit specimens of this variety of machine.

Mr. J. Marston, of Wolverhampton and Holborn Viaduct, exhibits some neat safeties, in which the frames are made of double tubes ⅝ in. diameter instead of the usual large size tube. With a 30 in. front wheel and 28 in. back wheel, both with ¾ in. tires, the weight is reduced to 36 lb. for a full roadster, while a racer of the same pattern is 30 lb. This maker shows the lightest machine we noticed, viz., a racer bicycle with 26 in. equal wheels, the weight being only 15½ lb. In some of the cycles shown by this maker the driving chain can be tightened by means of Marston's patent eccentric chain adjustment. This is accomplished by the bearing of the crank axle being carried in an eccentric which can be turned round as the chain stretches until the tightening length is equal to the throw of the eccentric.

One of the most striking objects in the exhibition is a Hansom cab on five wheels, the front small wheel being a steerer and the four wheels behind the cab being driven by four riders. This machine is exhibited by the Coventry Machinist Company, and has been manufactured for the Sultan of Morocco. The interior of the cab is well upholstered, and it contains a sliding seat on which the Sultan can sit cross legged. The machine can be steered from inside the cab or from the rear by the riders. The machine is highly finished, the bright parts being all nickeled, and is a good specimen of what can be done in the cycle trade.

A novelty is shown at the Pneumatic Tire Company's stand. The usual solid rubber tires are replaced by hollow rubber tires 2 in. in diameter. These are inflated by a special force pump, and it is claimed by the makers that they deaden vibration. The tire is not of uniform thickness around its circumference, but is thicker on the wearing surface than elsewhere. A safety bicycle fitted with the special tire is exhibited by this firm, and though it has been ridden for 1,000 miles, the tire appears to be none the worse for wear. Three or four other firms also exhibit this particular form of tire.

Among the novelties is a "water cycle," shown at Stand 230. This boat is worked by two riders in the ordinary cyclist manner, who drive a crank shaft which is geared to the paddle shaft. The boat is balanced by a pair of small outrigger floats, one on each side, and they can be raised or lowered by a lever within reach of the drivers. The boat will carry four persons.

A counterpart to the water cycle is to be found in Rudge's "road sculler," fitted with hand propelling gear and a sliding seat. This machine has been designed for the use of oarsmen. The machine exhibited by the Rudge Cycle Company, Limited, has 40 in. side wheels and a 22 in. front wheel. This firm has a good show, and in addition to ordinary machines they exhibit their "invalid" tricycle and their "parcel carrier." Their novelties for the season consist of a spring frame and a spring handle.

Mr. George Cousins, Birchington-on-Sea, Kent, exhibits a very light safety bicycle. The frame itself is its own spring, and it is formed of ½ in. square steel. The back wheel is large and the front one small. The seat is placed back about 45 deg. from the driving axle, and instead of the usual small saddle, the machine is fitted with a broad seat and a back rest. The weight of the machine is 48 lb.

The Goulden Syndicate, Limited, Clapton, London, show a variety of their "Golden Era" cycles, including a military safety, in which the rifle is simply laid in sockets and not fixed. The frames are rigid, but the vibration is taken up by a spiral spring insulator on the hind wheel.

M. John Pollitt, Lower Mosley Street, Manchester, shows several machines fitted with the "Collier" instantaneous change gear. This is a contrivance by which the cycle can be reduced in speed for hill climbing. It contains one pinion only, which drives the chain wheel at the lower speed, which reduces the speed of the machine one-fifth. At the higher speed the pinion remains in gear with the chain wheel but does not work, and the whole is revolved as an ordinary chain wheel. The speed can be changed from the handle bar by a spring catch and levers withdrawing a bolt, which locks the pinion and chain wheel together. The gear is covered by a dust cap in actual work, and can be fitted to any ordinary machine.—*Industries.*

A WATER WALKER.

PASSING along High Street, Camden Town, a day or two ago, I ran across this machine being conveyed to Regent's Canal on a barrow; on reaching the canal it was launched, and floated like a cork. The inventors,

A WATER WALKER.

Mr. Petts and Mr. Willis, took their seats and started on the trial trip, which appeared quite satisfactory. At one time there were four persons on it, and it will support six. The machine is a tandem machine with four drums. The fans are movable and work with a spring. They spring back flat against the surface of the drum directly they leave the water. The machine weighs 2 cwt., and measures about 12 ft. in length. It is steered by a rudder worked by wires similar to a boat. The speed is about equal to that of an average walker. —*London Graphic.*

TESTING THE FORTH BRIDGE.

As a preliminary to the passage of the first train over the structure on January 24, the Forth bridge was tested on January 21 by Mr. John Fowler, Mr. Benjamin Baker, Mr. Arrol, and Mr. Stuart, of London, the last of whom was chiefly responsible for the mathematical calculations in connection with the structure. At 10:30 A. M. two trains, each consisting of three engines and fifty wagons loaded with coal, began to steam slowly across the bridge from the South Queensferry end. The trains moved along abreast of each other at almost a walking pace, and stopped every now and then to enable the engineers to examine the levels and look out for deflections. The official report was most satisfactory, as the deflections observed were in exact accordance with previous calculations, and the bridge has been burdened with a load of 1,800 tons, more than double what it will have to bear in future. On January 24 the first train crossed the Forth bridge from end to end. It consisted of an engine and tender, a saloon carriage, and a brake van. On board of it were Lord Colville, of Culross; the Marquis and Marchioness, of Tweeddale; Lord Dalrymple, Mr. Thompson, and other railway magnates. During part of the journey Lady Tweeddale took charge of the engine, and brought the train over the bridge at a steady pace of ten miles an hour. The incident was witnessed by thousands of persons. All being well, the Forth bridge will be officially opened by the Prince of Wales on March 4.—*The Graphic.*

THE NEW RESERVOIRS AT MONTMARTRE.

ON the summit of Montmartre—the highest point of Paris—vast reservoirs have just been built to supply the whole of the population with water, which up to the present time has been very limited in quantity. Situated at the side of the Church of the Sacre Cœur, bordered by Azais and St. Eleuthere Streets, they occupy a surface of 2,300 m., and are composed of two distinct and perfectly separated parts, the first with two stories and the second three. The lower story of each reservoir stores 4,800 cubic meters of river water at an altitude of 127·30 m. The second story, with a capacity of 4,200 cubic meters, receives and distributes water direct from the source. The third story of the great reservoir also contains 2,000 cubic meters of spring water, which it can send to the old Chateau reservoir at the top of Lepic Street, which can only contain 450 c. m., but which serves as a distribution tank for the higher regions of the Mount. These 11,000 c. m. are raised by works constructed at the foot of the Mount, which draw the spring water through the distribution pipe of the Dhuis reservoir and the river water through the return pipe of the Bercy works.

Much study had to be devoted to the establishment and the construction on a soil excessively unstable, and which, from its geological constitution, necessitated great precautions to protect it from the danger of landslips.

The accompanying engraving—Fig. 8—shows that when once a virgin soil is reached, a bank of yellow sand is found preceding the layers of gypsum, the thickness of which is about 3 m., very fine and easily carried away by water. It was necessary then to avert the considerable change which presents itself here, either from infiltration through the masonry or from the cracks which are almost infallibly produced in the floors. With this in view, the principal floor has been made with a layer of concrete, covered over the whole extent with impenetrable cement mortar, leveled in such a manner as to form a series of trenches, at the bottom of which are the drainage pipes, all running into a small gallery, which forms a collector beyond the works. A second bed of concrete, the total thickness of which

THE FIRST TRAIN OVER THE NEW FORTH BRIDGE.

is 0·75 m., is run over the last covering, and finished horizontally to receive the masonry. The infiltrations are thus collected and drained off. This floor itself forms the ceiling of an under chamber easily accessible, enabling the arch which supports it to be thoroughly inspected. The network of galleries, 2·40 m. in height and 2 m. wide at the springings, form a series of supporting arches, the pillars of which are the base of the pillars of the reservoirs. The floor of this under chamber is cemented over where coming in contact with the arches and pillars, which are rough, in order to permit of the free flow of the water running through from the upper fissures. Finally, in order to prevent the escapes which would take place in the embanked part of the surrounding walls, and the existence of which would run the risk of being unperceived for some time, one of the outer recesses of these walls has a covering with trenches, and drainage pipes running into the galleries of the under chamber. The lower story of the small reservoir, and the first two of the large one, are constructed in the center with supporting arches, and round its circumference with inverted arches, the outer walls being joined to the floor by inverts 2·50 m. in radius. The two upper stories are covered by means of elliptic brick arches, of a total thickness of 0·07 m., and a rise of 0·60 m. for 3·55 m. span; the abutment piers are isolated from the circumference

Fig. 6.

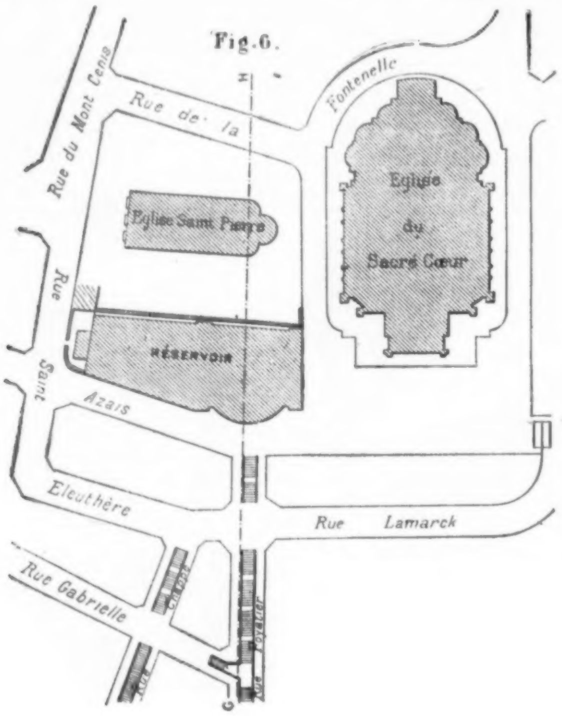
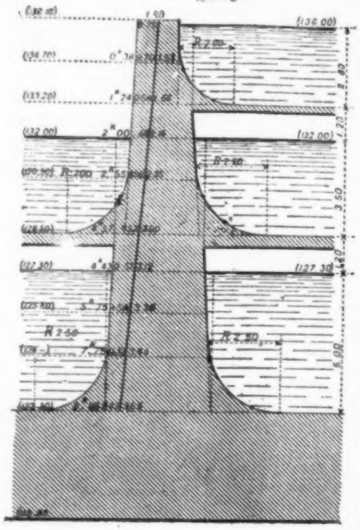


Fig. 7



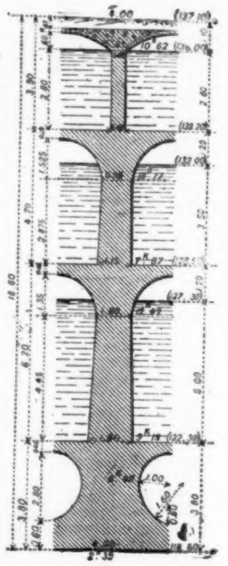


Fig. 8.

Fig. 1.

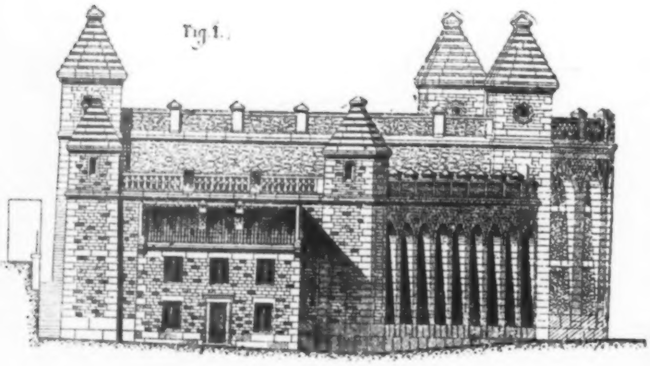


Fig. 2

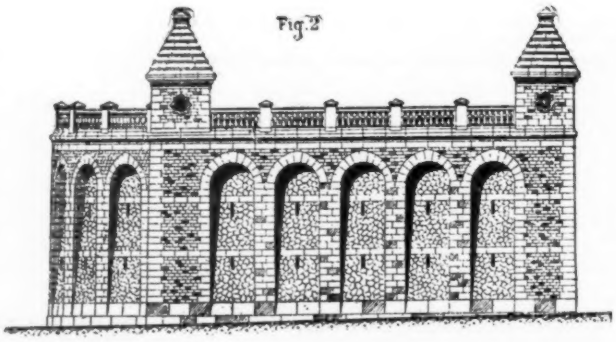


Fig. 3

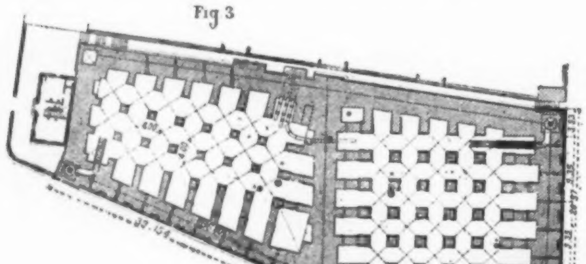


Fig. 4

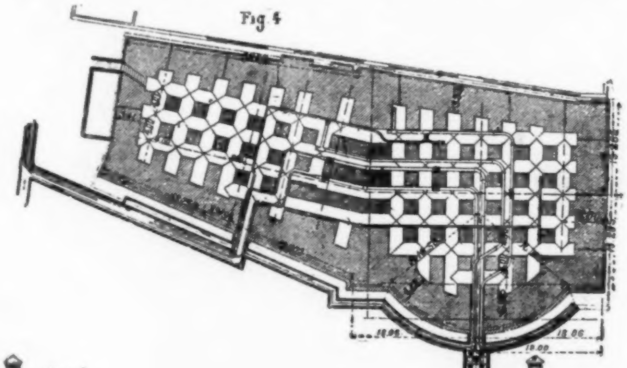
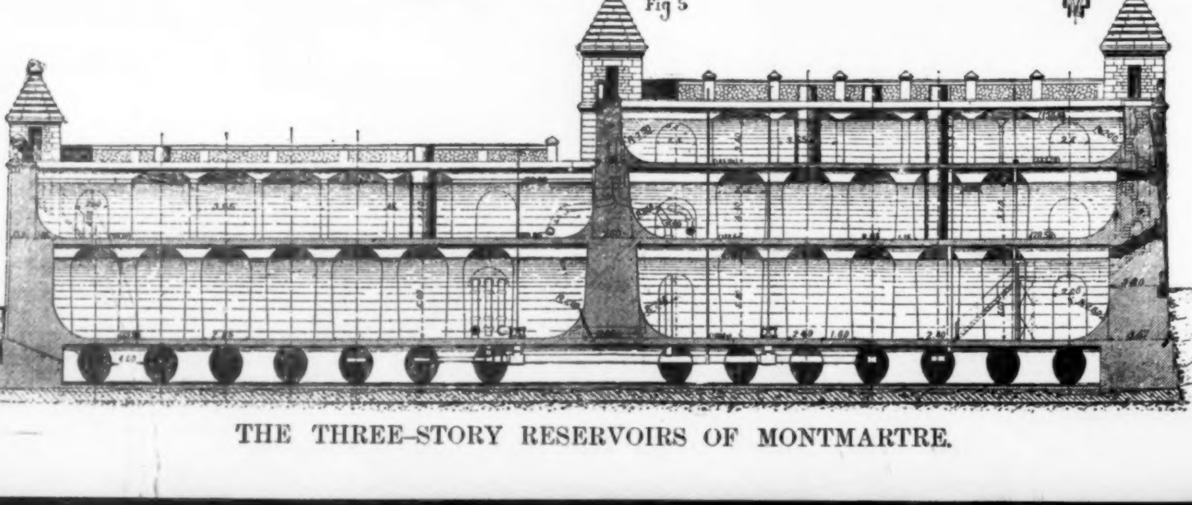


Fig. 5



THE THREE-STORY RESERVOIRS OF MONTMARTRE.

walls, as also from the covering itself by a space of 0·10 m., simply covered by brick placed flat without mortar. The spandrels of the arches are filled with concrete surmounted with a covering of cement and turfed over. The composition of these vaults is as follows:

	Meters.
(1.) Great reservoir:	
Lower story: Depth of water	5
Depth under keystone	5·80
Span of the vaults in center	2·70
Thickness of the pillars	(1·60+1·30)÷2
Middle story: Depth of water	3·50
Depth under key	4·40
Thickness of pillars	(1·15+0·95)÷2
Upper story: Depth of water	2·80
Depth under key	3·40
Thickness of brick pillars	0·45
(2.) Small reservoir:	
Lower story: Same as lower story of great reservoir.	
Upper story: Depth of water	3·50
Depth under key	4·30

The surrounding and partition walls are calculated after the most unfavorable hypotheses, which are never realized in practice; all the stories reckoned as full, the isolation of the abutment piers of the arches of each story is assumed, and no account is taken of the support from the embankments, or for the partition wall, the counter thrust of the small reservoir. Under these conditions is found: (1) Minimum distance of the facing of the wall from the curve of the pressure: Great reservoir, 0·67 m.; small reservoir, 0·36 m.; partition wall, 0·47 m. (2) Maximum pressure on stoppage of shutting off: Great reservoir, 9·12 k.; small reservoir, 8·92 k.; partition wall, 9·65 k.

The vertical pressures, on account of the oval form of the lower galleries, is uniformly divided over the whole surface of the foundation floor. From 12·62 k. at the springings of the lower story of the great reservoir—Fig. 5—they fall thus to 2·39 k. For the small reservoir they are 12·03 k. and 1·70 k. At the base of the south wall there has been added an abutment apron—see engraving, Fig. 8—jutting out to prevent the removal of the bed soil there by underground water. This precaution has been taken because it was found at this point that they were near the limits of the old embankments or of the made ground. The masonry is of millstone, with Portland cement and mortar, 470 kilos. per cubic meter of sand for the lower and middle stories, and of Burgogne bricks for the upper stories.

The decorative parts only are in rough ashlar facings, except the cornices and the covering of the towers, which are chisel dressed. The plasterings are of Vassy cement and sifted sand, 0·02 m. for the pillars and surrounding walls, 0·03 m. for the floors. As we have said, this is not applied to the intrados. The pillars of the upper stories are also uncovered, but they rest on the general coating of the corresponding floors. The lighting and ventilation are secured by lateral rectangular openings made in the outer wall, and by lights admitted through the top of the covering at one part, and another by the shafts of 1 m. in diameter, which are open to the air on the earthworks, and give access to each story for the descent of materials in case of repairs being required. We have already stated that the two lower stages are destined for river water. The feed pipe, 0·40 m., for this runs into the 127·30 m. tank, from whence the two supply pipes of these reservoirs run out. The feed pipe of the spring water, also 0·40 m., ends at the side 132 of the supply tank of the two second stories. It is lengthened by a branch of 0·30 m. as far as side 136, to permit of the intermittent filling of the upper story by the occlusion of the supply of the tank. The play of these two principal pipes is governed by five valves, placed at their extremes into the central gallery of the lower chamber, and enables use to be made at will of either the spring or river water. The distribution pipes are 0·50 m. diameter, except that which unites the upper story of the great reservoir with the reservoir of the Chateau, which is only 0·25 m. Each story is provided with distribution and emptying sluices, worked by means of apparatuses placed on the earthworks of the reservoirs.

The works were executed between 1887 and 1889, under the direction of M. Bechmann, chief engineer, on the plans of M. Journat, engineer in ordinary, under the conduct of M. Dutoit, principal contractor. The masonry was undertaken by M. Lagies, and the waterworks by MM. Mathelin and Garnier. The approximate expense has amounted to:

	Francs.
Earthworks and masonry	970,000
Waterworks	30,000
	1,000,000

The particulars and engravings are from *The Engineer* and *Le Genie Civil.* Fig. 1 is the west elevation of the buildings; Fig. 3 is a horizontal section; Fig. 2 is the east elevation; Fig. 4 is a horizontal section at the lowest story seen in the vertical longitudinal section, Fig. 5; Fig. 8 shows the geological formation below the reservoir; Fig. 6 is a general plan of the new reservoirs at Montmartre, and the adjacent streets and buildings; Fig. 7 is an enlarged section of the partition wall, showing by figures and a line the magnitude of the pressures and direction of the forces at any point; and Fig. 9 is a section through the piers, and by figures gives the pressures on the masonry and on the foundation.

LABORS OF THE INTERNATIONAL BUREAU OF WEIGHTS AND MEASURES.

THE first meeting of the General Meter Conference was held at the pavilion of Breteuil (St. Cloud Park), from the 24th to the 28th of September, 1889. The mission of this conference was to sanction the labors of the International Bureau of Weights and Measures, and to receive the metrical prototypes designed for the subscribing states of the meter convention. It consisted of the International Committee of Weights and Measures, of the French section of the Meter Commission, and of the diplomatic or scientific delegates of the states represented in the reunions of 1872. The president of the Academy of Sciences was the president of it *de jure.* The Minister of Foreign Affairs, desirous of showing the great interest that the government took in this conference, opened the first session himself.

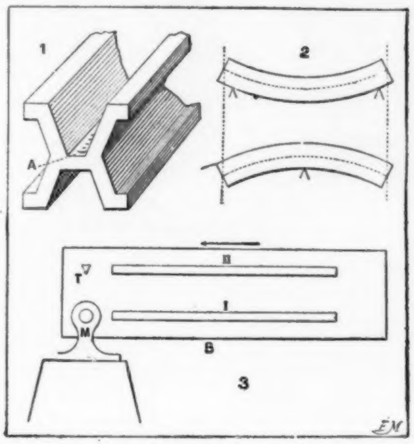


FIG. 1.—Standard Meter. FIG. 2.—Flexion of the Rules. FIG. 3.—Device for Graduating the Meter.

We shall say but little of the conference itself, of which we might give a pretty accurate idea by merely reproducing the speeches that were delivered. It was at the second session that the prototypes received their official sanction, and were distributed by lot among all the states. The international meter and kilogramme, so exact copies of those of the Archives that it is impossible to detect the direction of their errors, were placed in the strong box, situated in a deep cellar closed by three locks, whose keys were respectively in the hands of the director of the bureau, of the president of the committee, and of the guardian-general of the Archives.

The extraction of these standards by an officer of the International Bureau was, therefore, subordinated to the authorization of the International Committee and the French government. It could take place only in the presence of the depositaries of the various keys. These precautions, which at first sight seem to be a little excessive, were necessary in order to give all the states the absolute guarantee that the fundamental standards of the metrical system should run no danger of being injured by ill-disposed or careless persons.

As we have said, the mission of the conference was to sanction the labors relative to the new prototypes of the metric system. We propose to pass these various labors rapidly in review.

It will be remembered that the Meter Commission, renouncing the primitive and theoretic definition of standards, decided simply to copy the meter and kilogramme of the Archives in their present state. The problem was, therefore, reduced to the making of these copies, then to the getting up of immutable standards for the states, and to the determining of their exact value.

The selection of the metal was a subject of profound discussion. The material for the meters and kilogrammes had to be very hard and unchangeable with time, not attackable by atmospheric agents and by ordinary chemical agents, and very refractory, in order to resist even the temperatures that might accidentally occur in the fire of a laboratory.

The important labors of H. Sainte-Claire Deville led to the adoption of alloy of platinum and iridium (the latter in the proportion of 10 per cent.) This metal is extremely hard; its resistance verges on that of steel, and its temperature of fusion is that of dazzling white (according to Mr. Violle, 1,775° for platinum and 1,950° for iridium).

The metal necessary for the construction of the metrical standards was ordered from Messrs. Johnson, Matthey & Co., of London, who, after long researches, succeeded in purifying it. The difficulties of separating the last traces of rhodium and iron from the iridium were, says Mr. Matthey, almost insurmountable. It took no less than eleven consecutive analyses, the result of which was not declared satisfactory till October 18, 1885.

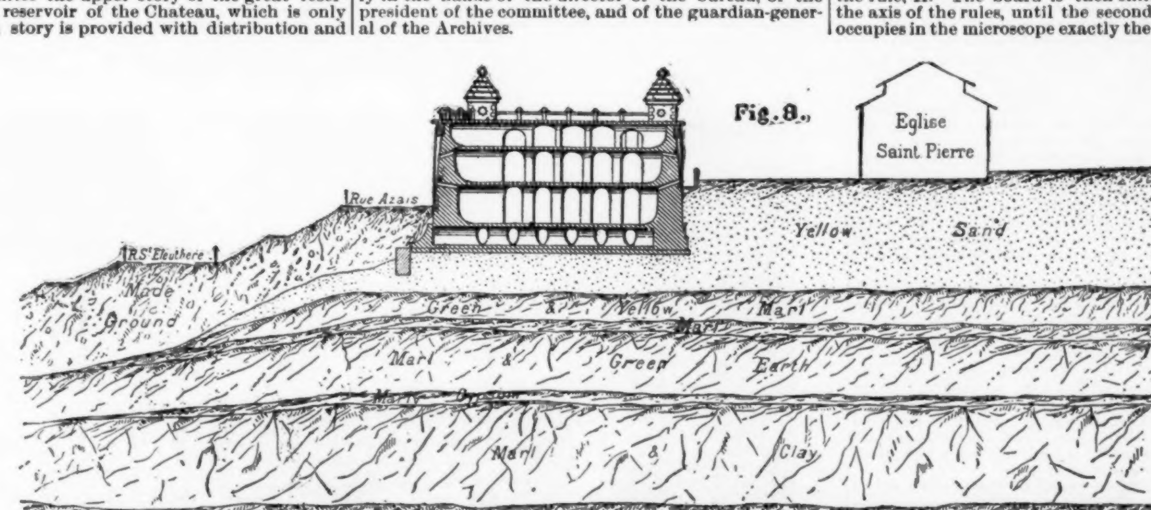
The hardness of the metal, which is an important quality for the construction of standards, rendered the manufacture of them particularly difficult; it was necessary, from the lessons of experience, to modify the tools employed for planing metals. Finally, after numerous experiments, the first rule was delivered in April, 1886.

The rules have the form shown in Fig. 1. This form, which is odd, at first sight, has been so calculated by Mr. Tresca that the distance of the divisions limiting the meter and engraved upon the surface, A, are independent of the support of the rule. Fig. 2, in which the flexions are purposely exaggerated, shows that the upper surface of a rule elongates or contracts according as it is supported at the center or at the ends. The median line, called the surface of neutral fibers, remains sensibly invariable. The X-shaped standard has been so calculated, moreover, as to effect as much saving as possible in the very costly material.

Most of the old standards of precision are very delicate and can be handled only with the greatest care, if it be desired to prevent permanent distortions; the new ones, on the contrary, are exceedingly strong, and are capable of undergoing shocks without danger. Accurate experiments have shown that a weight of forty kilogrammes can be suspended from the middle of an X-shaped meter without permanently modifying it.

The rules, delivered in a crude state by Messrs Johnson, Matthey & Co., were finished and cut to the length of 102 centimeters by Messrs. Brunner Bros., of Paris. Then they were polished and engraved at the Conservatoire des Arts et Metiers. A beginning was made by polishing a space near each extremity, and then the rule was placed in a horizontal comparing apparatus, where it received the two lines defining the meter, and each accompanied with two other lines at half a millimeter from the central line. Thus there was obtained, at the same time with the metric standard, the micrometric standard, under the form of two millimeters. A brief description of this mode of engraving will doubtless interest some of our readers.

Upon a board, B (Fig. 3), is placed the model rule, I, and the rule to be engraved, H. The apparatus having been adjusted, the first line of the rule, I, is brought under the microscope, M. Then, by a proper movement of the diamond engraver, a line is marked upon the rule, H. The board is then shifted parallel with the axis of the rules, until the second line of the rule occupies in the microscope exactly the position in which the first was found; then a new line is engraved upon H, and so on. The entire engraving is done without the operator seeing his work; it is not until he has finished it that he can examine it. The least defect necessitates the entire work being begun over again, for in view of the precision that it is necessary to expect, it is impossible to *mend* an interrupted division. This



THE MONTMARTRE RESERVOIRS—GEOLOGICAL FORMATION.

difficult work, performed by Mr. Gustave Tresca, has succeeded in an unexpected manner; one of the first meters engraved, compared with the standards at the International Bureau, served as a type for the rest of the operations. Now, among the thirty meters thus engraved, there is none whose equation reaches 3μ (three thousandths of a millimeter), and the mean of all is exactly equal to the International meter; whence we conclude that there was no systematic error in the instruments.

We shall not expatiate upon the manufacture and adjusting of the kilogrammes, which presented difficulties of another nature and not so great. The iridium-platinum cylinders that served for this were strongly compressed in a powerful apparatus in order that all the small internal cavities might be crushed. The movement of the density shows the continuity and, within certain limits, the purity of the metal.

While awaiting the delivery of the standards, the Bureau occupied itself with the elaboration and improvements of the methods of comparison. The first apparatus, which were quite imperfect, were partially replaced with those which have already been described; and others completed the collection.

A long series of comparisons had put the Bureau in possession of provisional standards of the meter and kilogramme, whose equations with respect to the standards of the Archives were exactly known. But it was still necessary to determine a certain number of copies for the labors of the Bureau, to measure their expansion, and to get up standards of the subdivisions of the meter and kilogramme.

On this subject a few words of explanation may not prove amiss. To speak only of the measurements of length (the same reasonings and nearly the same processes are applicable to the masses), we may say that although there exists in the world *one* meter exact by definition, it cannot be pretended that we have a perfectly accurate single decimeter, centimeter, or millimeter. Remaining within the limits of practice, we can assert that in a well divided meter there are but very few millimeters whose error is less than the limit of the errors of observation.

If we desire to find the error of a millimeter, we begin by comparing the divided meter with the meter exact by definition. Afterward, on comparing the decimeters with each other, we ascertain the excess of each of them over their mean, and, consequently, the error of each separate decimeter. Afterward, by an analogous process, we pass from decimeters to centimeters, and from centimeters to millimeters.

This operation which we are describing in a few words takes nearly a year of assiduous work. It may be done by means of an instrument called a universal comparing machine—called universal because it permits of measuring all the lengths between certain limits, while most comparing apparatus are designed solely for measuring definite lengths, generally one meter or several meters.

The universal comparing machine (Fig. 4) consists essentially of two microscopes, M, movable upon a very massive cast iron bridge, A, supported by stone pillars, P. The rules are placed upon two supports, B, capable of being moved in all directions.

The tests can be made by different processes. The simplest consists in fixing the two microscopes upon the bridge at an invariable distance, say of 1-10 m., for example, and in making all the decimeters of the rule pass successively in their field. The two microscopes thus form an optical compass by means of which each decimeter is measured separately.

We shall speak further along of the various other labors undertaken by the Bureau. For the present we wish to terminate what concerns the study of the prototype standards designed for the subscribing states. Here again we shall speak only of the meters, of which thirty have been delivered. For the kilogrammes, forty in number, the principle of the methods of comparison was exactly the same.

The standards were designated by numbers, arranged upon horizontal and vertical lines. Each standard was then compared with all those of the same horizontal line and of the same vertical column. Each comparison of two meters was made four times, by alternately placing one end of each of the rules to the right and left of the observer.

The series of comparisons of the meters numbered 784, to which must be added nearly 400 series for the measurements of the expansions. As each series comprised 6 measurements of one rule and 5 of the other, we reach the very respectable number of about 13,000 measurements. This required an uninterrupted labor of two years.

The measurements were made independently by several observers and by means of various apparatus. Their variations therefore give a good criterion for the accuracy of the same. They also indicate the limit that it is now possible to obtain. A profound study leads to the admission that the errors of the equations scarcely exceed 0·2μ (two ten-thousandths of a millimeter) for the rules, and are certainly less than 0·01 mg. for the kilogrammes. The accuracy of the weighings, greater than one hundred thousandth, or to a magnitude corresponding to 10 centimeters upon the terrestrial quadrant, is the greatest of all that can be obtained in physical measurements.

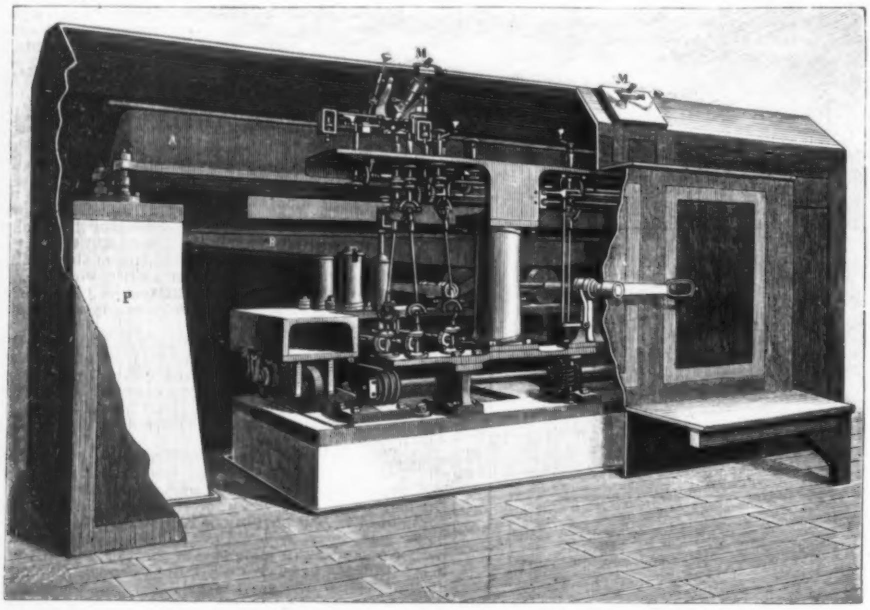


FIG. 4.—UNIVERSAL COMPARING MACHINE.

For many years in most civilized countries it has been the custom to measure off great systems of triangles that permit of fixing the relative position of a certain number of points of the earth's surface very accurately. To this effect, a start is made from a base of a few kilometers measured with great care, and, after a large portion of the country has been gone over, a return is made to a new base which serves to verify the accuracy of the measurements. Sometimes the geodesists of two neighboring countries enter into an arrangement to determine independently the side of a triangle situated in proximity to the common frontier. Now, it has been found that the differences between the values ascertained for the same line, in starting from two different triangulations, are often much greater than would have been expected, being given the concordance obtained with the bases of control. Hence, it was naturally granted that the fault was in the starting bases, and that the rules used in measuring them presented notable differences. The authentication of this had much to do with the founding of the International Bureau of Weights and Measures, one of whose missions is to determine the exact value of the rules employed in geodesy. It was with such an object in view that was constructed the geodesic comparer, which has already served for measuring several important rules. In measurements upon the ground it is necessary to diminish the number of stretches as much as possible, and consequently to make use of as long rules as the question of height and solidity permits of employing. To-day, the length of 4 meters is agreed upon. The geodesic comparer is constructed upon that basis. This instrument, of which we give a plan in Figs. 1 and 2, and a general view in Fig. 4, serves to adjust the rules; that is, to determine their length, starting from the meter, and also to determine their expansion. It is constructed as follows: A large base of beton, 6 meters in length, 4 in width, and 3 in height, supports seven monoliths upon which are fixed as many microscopes provided with micrometers. Five of these microscopes are placed in a straight line at a distance of one meter apart, and the two others are four meters apart in a straight line parallel with the first. Two troughs, with double sides, supported by a strong cast iron carriage, serve to receive the rules, which are placed upon supports provided with the necessary regulating movements. The carriage runs upon rails, and is actuated by a strong screw placed beneath. Up to this point, the apparatus hardly differs, except in size, from the comparers before described; but what gives it a very peculiar character among instruments of precision is the very important use made of electricity in it. The microscopes get their light from small electric lamps, provided with collimators, and the agitators that serve to stir up the water vigorously so as to secure a uniformity of temperature are actuated by small dynamos. It is also an electric motor that, through the intermedium of the lever, moves the carriage and the troughs, which, together, weigh more than four tons. Finally, a dynamo outside of the hall actuates two turbines which continuously pump out the water contained between the double sides of the trough. This water, cooled or heated, according to the requirements of the experiment, returns through its own weight and keeps the water of the internal trough at a constant temperature.

It is easily seen how the apparatus thus constructed serves to solve the multiple problems of which we have spoken. If it be desired to regulate a 2, 3, or 4 meter rule, the latter is placed upon one of the supports of trough No. 1, and upon another support opposite the first is arranged a standard meter. Then, by means of microscopes, the value of the first meter is measured and is compared with the standard meter. The latter is then moved one meter toward the right, and so on. The expansion is measured by comparing, by means of special microscopes, the rule to be studied (placed in the first trough and raised successively to various temperatures) with a comparison rule placed in the second trough and kept at a constant temperature. It generally takes from 6 to 10 hours to fix the temperature of the two troughs properly. The measurements made by two observers take from 2 to 3 hours. One comparison can therefore be made in a day of from 8 to 12 hours' work. The measurement of an expansion requires twenty comparisons. Counting the start and a few delays, it may be said that the measurement of the expansion of a geodesic rule requires the co-operation of two observers for a month.

Thermometric Researches.—There is scarcely a measurement, no matter in what science, in which the determination of a temperature is not concerned, either as a simple accessory datum or as an important part of a research. In meteorology the exact measurement of a temperature is an absolute necessity. It is utterly useless to know the length of a rule to nearly a ten thousandth of a millimeter if one cannot say, at least to about a hundredth of a degree, to what temperature such length corresponds. While, then, the very precise methods for the measurements of lengths were being elaborated, it became necessary to carefully examine the thermometric processes. As the importance of the question gradually increased in measure as researches continued to be made, the necessity was recognized of establishing at the international bureau a genuine thermometric service on a par with that of the measurements of lengths or weights. This service was divided into two parts; on the one hand, mercurial thermometers were studied, and, on the other hand, the gas thermometer. Up to recent years, the mercurial thermometer has been greatly condemned. There have been attributed to it all sorts of causes of variability that rendered its indications absolutely inaccurate. In such an opinion there is something both true and false. It is possible to guard against the most periodical variations by a judicious selection of

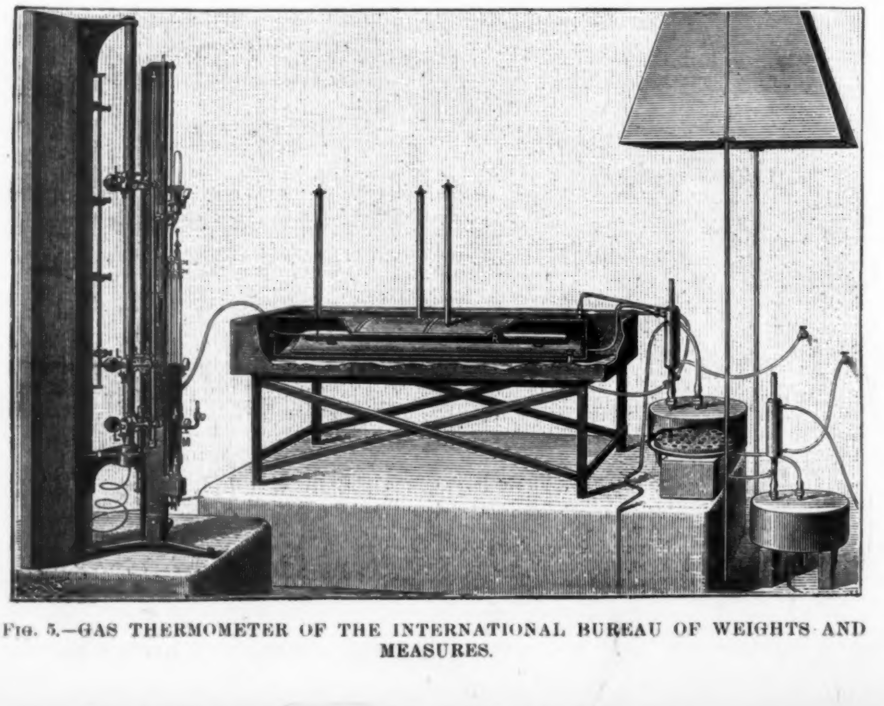


FIG. 5.—GAS THERMOMETER OF THE INTERNATIONAL BUREAU OF WEIGHTS AND MEASURES.

the glass of which the thermometer is made, and also may be eliminated by a rational mode of operation.

When a thermometer is heated for some time, the indication corresponding to the temperature of fusion of the glass lowers; but, if the heating be continued, the zero begins to rise in consequence of a sort of annealing of the glass. Mr. Crafts has produced elevations of the zero reaching 26 degrees in flint glass thermometers heated for hours at 355 degrees. It is found by the use of hard French glass analogous variations are reached to a quantity nearly ten times less. The effects of annealing in thermometers heated to 100 degrees are scarcely appreciable, and experience has proved that in such thermometers all the *constants* (that is to say, the volume comprised between the zero and hundred points, the relative volumes of various parts of the tube, etc.) are absolutely invariable with time. But, in all the thermometers hitherto constructed there has remained a variation of the zero point with the temperature. Now the effect of such variation may be completely eliminated by considering the indication of the thermometer as constituted by the difference between the reading and the position of the zero determined immediately afterward.

In studying the thermometer, all the differences of tube diameter are measured by observing the length of several columns of mercury at different points. Afterward the value of the degree and the elasticity of the reservoir are measured, so that the variable pressures that it undergoes from the exterior or interior may be determined upon applying the corrections thus determined to the measurements. The indications of the thermometer are made to correspond with those of an instrument of the same material without defects. Now, it has been demonstrated by numerous experiments that all the thermometers of the same glass, studied and corrected separately, give indications that are identical to within about a few thousandths of a degree.

As the true measurement of temperatures is given by the gas thermometer, it became necessary, for a group of thermometers, to determine the difference between their indications and those of a gas thermometer. The indications of all mercurial thermometers made of the same glass could then be made to agree with the scale of the gas thermometer after these thermometers had each been submitted to study.

The new gas thermometer of the Bureau is represented in Fig. 5. It consists of a reservoir, R, of iridized platinum of a capacity of about one liter, and of a pressure gauge. This reservoir, which was once used in some important experiments by H. Sainte-Claire Deville and Mr. Mascart, belongs to the Institute of France, and is something unique. The pressure gauge, M, is of peculiar construction. The open branch serves as a barometer cistern, and, as the pressure that acts upon the gas consists of the manometric pressure increased by the actual barometric pressure, we can dispense with determining the position of the meniscuses of mercury in the open branches of the barometer and pressure gauge, since these meniscuses coincide. In Fig. 5 simplified, the pressure of the manometer or pressure gauge is A B, and the atmospheric pressure is balanced by the height of mercury, B C. As the two meniscuses are confused at B, the total pressure is A C.

In order to read the position of the meniscuses, we examine, through the two telescopes, L L (Fig. 5), the interval comprised between a point of glass and its image in the mercury, and by a rotation of the cathetometer, D, we lay off this length upon a rule. As the temperature, by definition, is proportional to the tension of the gas, the pressure thus measured permits of measuring the temperatures indicated by the gas. If mercurial thermometers be placed in the trough full of water of the reservoir, R, or, as shown in the figure, in tubes in which there is a circulation of steam, we shall be able, in noting their indications at the same time that we determine the pressure, to know their correction as compared with the gas thermometer.

Up to the present, mercurial flint glass thermometers have been compared, between $-25°$ and $+100°$, with carbonic acid, nitrogen, and hydrogen thermometers. It was in the train of a long series of researches that the international committee decided in 1887 to adopt the Centigrade scale of the hydrogen thermometer as the normal thermometric scale for the international service of weights and measures.

The diagram (Fig. 6) shows the variations of different

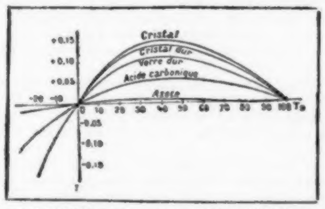


FIG. 6.—VARIATIONS OF THE INDICATIONS OF VARIOUS THERMOMETERS.

mercurial or gas thermometers as compared with the normal scale. The abscisses represent the temperature from $-25°$ to $+100°$. The indications of the hydrogen thermometer are confused with the axis. The variations of the other thermometers are figured as ordinates on a twice larger scale.

In conclusion, let us say further that each of the meters distributed to the states in the last conference was accompanied with two perfectly regulated mercurial thermometers with their tables of corrections. They will contribute to a unification almost as important as that of the lengths and measurements—the unification of the thermometer.

Many of our readers, we are sure, will now ask themselves this question: What is the use of measuring lengths masses, and temperatures with the precision that is now sought for? This question is very legitimate, and we shall try to answer it. Let us leave wholly aside the commercial and industrial point of view (in which we shall find condemnation only), and remain in the domain of science. The study of the form and constitution of the earth is one of the oldest problems that humanity has proposed to itself. It was once thought that the earth was flat, then it was admitted that it was spherical, and it was recognized toward the end of the seventeenth century that it was flattened in the direction of its axis. To-day another question arises: Is the earth symmetrical around its axis? Is it not rather an ellipsoid with three axes? An affirmative answer to this question would evidently solve that of the first meridian, the latter having logically to be taken through one of the principal axes of the ellipsoid. But this study is as yet incomplete, for want of a unification and sufficient precision in geodesic measurements. A micron per meter corresponds to 10 meters upon the terrestrial quadrant. Such exactness is necessary to-day, and greater exactness will soon be required.

Very precise weighings will permit of solving delicate problems of molecular or chemical physics.

The study of gases, for example, will be able to derive valuable data from weighings made in an artificial atmosphere hermetically inclosed in the cage of a balance. As for the measurements of temperature, so universally employed, we dare to say that the disfavor into which they had fallen has interfered with a goodly number of labors. Chemical mechanics, and in a general way thermodynamics, profits greatly from colorimetry. In the latter science many important questions were decided on the day on which precision passed from one per cent. to a value three times less. Now, as it is a question here of the measurement of intervals of from 3 to 4 degrees, it will be seen that the measurement to about a hundredth of a degree is absolutely necessary.

The day is not far distant on which, after the general methods have been somewhat still further improved, a precision of 1 per 1,000 will be sought, and then the measurement of temperatures to within two or three thousandths of a degree will be required. So much for the present time; but let us take a retrospective glance and see what precision was reached a century ago, and let us suppose that the progress of science continues for a century further the astounding pace that it has for the last hundred years, and we shall then see that the standards furnished by the International Bureau of Weights and Measures will very exactly correspond to a multitude of requirements. Will they absolutely suffice?

It would be imprudent to answer either yes or no. And this leads us to touch upon an important question —that of precision in general.

Those who have had most practice in measurements of precision estimate that, starting from a certain degree, the difficulties increase in a huge proportion—that of the square of the precision sought, according to geometers, but in a much larger proportion according to physicists. In reality, the true limit is given by qualities inherent to matter and to the observer. Whatever be the apparatus used by astronomers, the exactness of their measurements will always be limited by the irregularities of atmospheric refraction. So, too, a physicist will never be able to obtain a perfectly uniform temperature in a bath. For the one, as for the other, the faculty of estimating a distance by eye limits the exactitude of a point, and in a century such faculty will be the same as it is to-day.

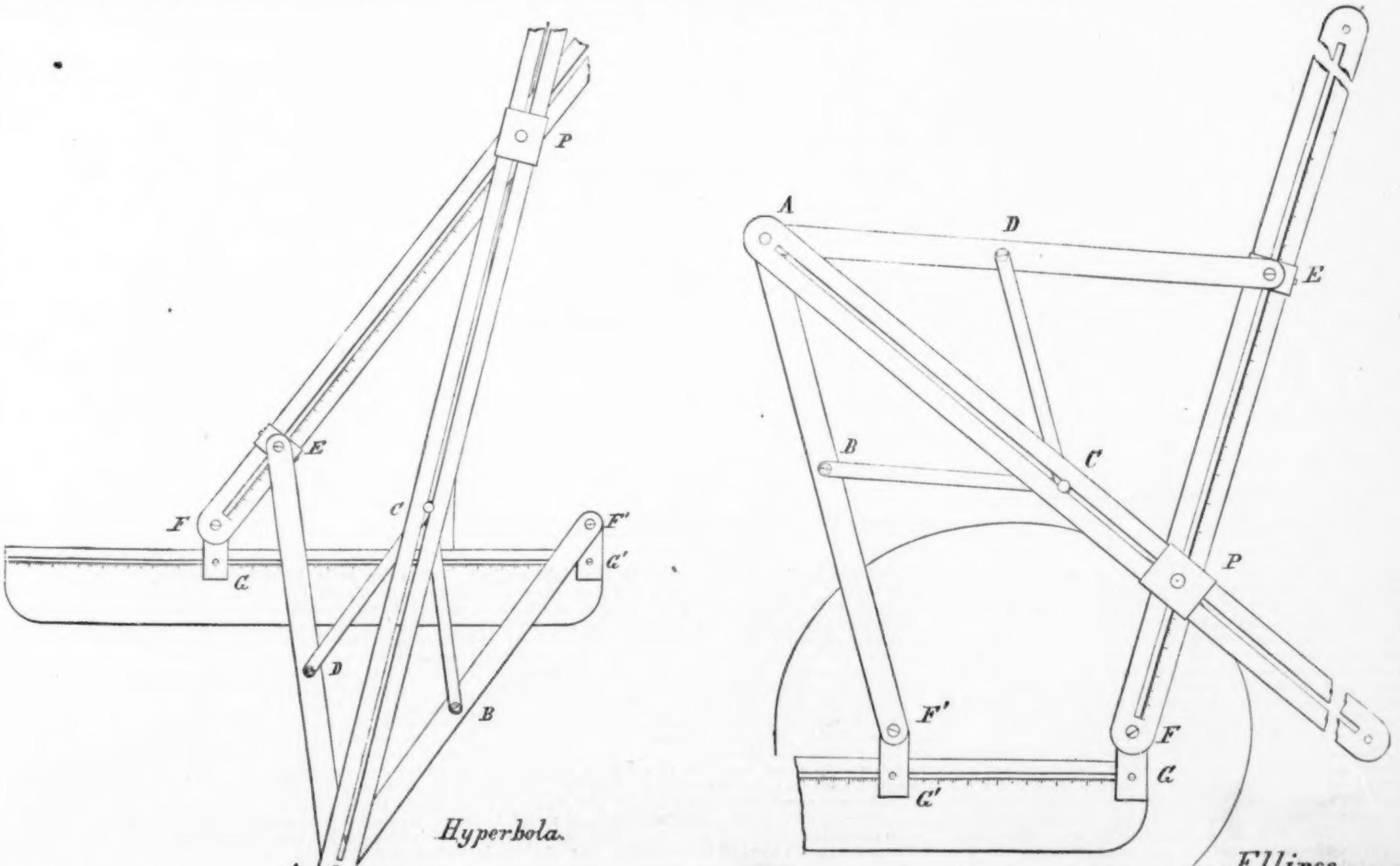
We should have liked to say a few words about the future labors of the Bureau, but we do not desire to tire the patience of our readers, who will pardon us for many dry details, and who will perhaps thank us for having endeavored to show through what long labors the unification of weights and measures, inaugurated by France and accepted by the larger part of the civilized world, has been prepared, and how great success has followed the effects attempted.—*La Nature.*

DESIGN FOR A CONICOGRAPH.

By ROLLIN A. HARRIS.

THE theory of this instrument can be readily obtained by inspecting the figures. We suppose the foci and transverse axis of an ellipse or hyperbola to be given. Let F F' denote the foci, and P a point upon the curve. E P always equals F'P (because A E = A F', A B = A D = B C = D C). Now if E F be taken equal to the transverse axis, then F P + F' P = E F. Hence P describes an ellipse or hyperbola.

At P is a draughting pen following simultaneously the two grooves A P and E P. In the lower groove, at P, is a rectangular piece fitted to follow this groove accurately. This piece is pierced by the pen, which turns in it freely.



DESIGN FOR A CONICOGRAPH.

But the pen is rigidly fixed in the piece following the upper bar, so far as rotation is concerned, and its edge always coincides in direction and position with the center of the upper groove. Since, then, the edge of the pen is always tangent to the curve, the line drawn ought to be of uniform width.

To draw an ellipse or hyperbola whose transverse axis and foci are given, lay off upon the graduated arm a distance, E F, equal to the given axis, and fix this distance by the clamp at E. Fix the distance F F′ by the clamps G and G′ upon the bed piece.

While the left hand holds the bed piece firmly in position, the right moves the pen, P, care being taken that the force exerted be directed along the bar A P.

Besides the parts shown in the figures, or referred to above, several washers should be used and all parts thereby brought to their proper levels. All bars, washers, etc., should be of uniform thickness for convenience in construction and operation.

It is thought best not to attempt the application of this method to the drawing of parabolas, for the practicability of the instrument, when modified for that purpose, seems somewhat uncertain.

AN INDEX PLATE FOR AMATEURS.

By Lieut. C. D. PARKHURST, U. S. A.

FREQUENTLY in amateur work an index plate becomes necessary, and the amateur is at a loss how to provide one that he can know is accurate. It is the writer's purpose to describe a method of constructing one that, with careful work, *will* be accurate, and give to the amateur a finished index plate of metal.

But few tools are necessary, and all that will have to be constructed are within the compass of an engine lathe, and can be made also upon a plain lathe, if the amateur is a skillful screw chaser. The special tools that will have to be made are all useful at all times for special jobs. So the amateur will have no useless tools on hand when the index plate is finished.

The material for the index plate and its form first claim attention. The writer has found that cast iron is the best material readily available, and, if for use with the lathe alone, one made like a regular face plate, to screw upon the nose of the live spindle, is the best form. This will be the particular form described, though the same method can readily be modified to construct other forms, as will readily suggest itself to the intelligent mechanic.

The index plate is then first got out as a face plate, and accurately fitted to the live spindle, and trued up all over. It is the better practice *not* to line off the face with concentric circles, or to polish this face. It should be simply faced off with a quick speed, and a fine feed and light cut for the final facing, so as not to leave any tool marks.

The *size* is a matter of moment. Of course, one would want as complete an index as possible, and size is necessary to give this, for otherwise the holes would be small, or very much crowded. It is recommended, therefore, that the size be made about as large as the lathe will swing—nine or ten inches, for instance—though, of course, a smaller size may be made.

Another advantage in a large plate is that any possible error is reduced when dividing up work, in just the proportion of the diameter of the plate to the diameter of the work being divided.

The form and size of the plate having, therefore, been determined, and the plate itself got out as above, the next thing is to prepare the tools with which to divide it up.

A long, straight strip of either spring brass or steel, about one-eighth inch thick and from one-half inch to three-quarters inch wide, is first procured. For a nine inch plate this should be about thirty inches long in the rough.

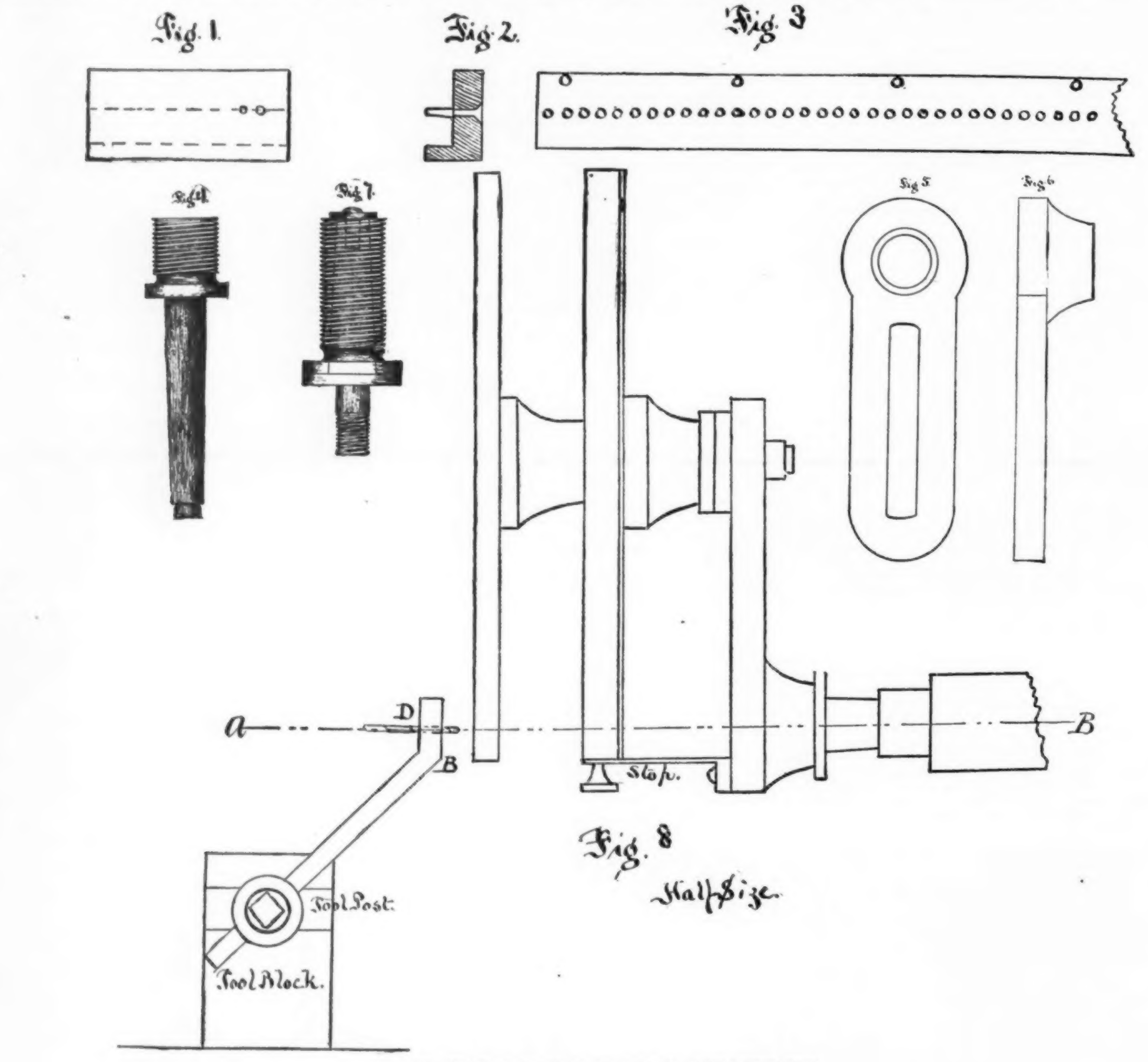
A block of steel about one and one-half inches long, one-quarter inch thick, and bent at right angles, so as to give a guiding edge, is then got out of a width so as to match the strip of spring brass. This is filed up so as to be true on the face adjacent to the right angle, and is then to be drilled with two holes on the center line, true with the guiding edge, and at a distance from center to center to be determined by calculation, depending upon the number of holes to be laid off on the index plate. The following is given as an example:

Suppose the diameter of the circle to be fitted with this brass strip (as will be hereinafter described) is ten inches, the circumference will be 31·416 inches, and the brass strip should be that long to form a band about that size circle. We wish to use this circle to divide our index plate into 240 equal parts. Then the holes in the brass strip must be 0·1309 of an inch apart, and, therefore, the two holes in the steel block must be the same distance apart, and such a size as not to cut into each other, and to leave a good strength of metal between the holes.

These two holes having been drilled, *one* of them is then fitted with a steel pin, made slightly conical on the exterior, and of size to fit the hole snugly and accurately. It may be fastened in in any manner convenient, and the block is then ready for use. See Figs. 1 and 2.

The strip of brass is now taken and drilled with a hole to match the *pin* of the steel block, and so that the guiding edge of the block bears truly upon the edge of the brass strip. The *pin* is entered into this hole, the block clamped or held firmly in place, and a second hole drilled in the strip, the drill entering through the hole in the steel block, the latter acting to center and guide the drill. The pin is now shifted to the second hole, a third hole drilled as above, and so on for any number of holes, care being taken to keep the block true, the pin properly in the last hole drilled as a new one is being drilled. By this means the holes in the brass strip will be accurately *in line* and *accurately spaced*, Fig. 3. On the *edge* of the brass strip a number of other holes may be drilled for the insertion of screws to hold the brass strip in place, as will presently be described.

The strip having been drilled, the next thing is to fit it to the form of a circle. *One more hole than the number required* should have been drilled, as, for instance, 241, and then the strip may be sprung to the form of a circle and a pin put through the end holes to hold it while being cut, or marked for cutting and fitting, so that the space between these two holes may be accurate when the circle is finally in place. The steel block may also be used for this purpose by fitting a pin in the second hole, and then only the exact number of holes may be drilled.



AN INDEX PLATE FOR AMATEURS.

When the ends have been properly squared and pointed as above indicated, the strip may then be made into a permanent circle by fitting a brass strip over the joint *on each edge*, so as to have the holes free. These plates may be fastened with screws or with solder, as is most convenient.

We now have a circular strip of brass accurately spaced with holes, and the next thing is to transfer the spacing to our index plate.

For this purpose a wooden disk to fill the brass circle is necessary. It is best made by fitting a wooden block upon any face plate belonging to the lathe, and then turning it accurately to size. It should be rigidly secured, and the center cut away, as will presently appear. Good, well seasoned wood should be used. Pear tree wood is as good as any if it can be obtained.

This disk having been turned accurately to size, and *with a shoulder*, the brass circle may now be fitted thereon and secured in place by screws through the holes in its edge, the edge bearing firmly against the above shoulder.

We now have some special tools to make to be able to use this disk and circle to drill our index plate.

Fig. 4 represents a "center" turned of steel to fit the hole in the lathe spindle, and with a "nose" of the same size and cut with the same thread as the "nose" of the lathe spindle, so that any face plate, chuck, or what-not that fits the spindle will also fit thereon. This will be found a very useful tool for constant use, as by its use work, chucks, etc., etc., can be transferred to the "back spindle"—the center fitting to the spindle.

Figs. 5 and 6 represent an arm, with slot, S. This arm can be of cast iron, the hub being bored and threaded to fit the lathe spindle, and the slot filed up true. The face should also be accurately faced off. This tool need not be made, however, if one has a large face plate available, with long slot in one side.

Fig. 7 represents a long "nose," the same size and thread as the lathe spindle, and bored as shown with a conical hole to receive a stud as shown. This stud is made with a threaded stem as shown, so that the whole affair may be fastened into the slot of Fig. 5 and stand firm and true, and turn freely upon the stud.

Fig. 8 shows the plan for the use of these special tools and the method of drilling the index plate.

The long "nose," Fig. 7, is fastened into the slot in the arm, Figs. 5, 6, by a nut and washer run up on the stem, at such a distance from the center as to give the necessary "set off" to bring the proper part of the index plate opposite the "line of center" of the lathe (the line A B, Fig. 8). On this "nose" the face plate with the wooden disk to its attached brass circle is screwed, and the blank index plate is also screwed upon the same nose until its shoulder bears firmly and truly against the face of the face plate. Both will then be truly in place and parallel. It is for this reason that the center of the wooden disk was cut away as above mentioned in describing the construction of the disk.

The center, Fig. 4, is now screwed into the arm, Figs. 5, 6, and the whole combination is fastened to the back spindle, by inserting the shank of this center into the spindle. Proper and final adjustment can now be made to bring the proper part of the index plate opposite the line of centers.

A spring "stop," with conical pin to fit the holes in the brass circle, is fitted to the face of the arm, Figs. 5, 6, as shown in Fig. 8. This serves to hold the revolving parts, composed of the wooden disk and the attached index plate, rigidly in position while the drill is being used.

Fitted into the tool part is a piece of steel bent as shown at B, Fig. 8. Through this piece of steel a hole is drilled to receive the drill, D, Fig. 8. This hole should be drilled by the same sized drill to be used in drilling the index plate, and the bar should be accurately placed so as to steady and guide the drill, but *not* to bend or spring it. It can be placed at such a distance back from the point of the drill as to serve as a stop to regulate the depth of holes in the index plate and cause them all to be the same depth. The tool carriage should of course be locked in place, and the tool block be fastened down so as not to move while the drilling is being done.

We are now ready for the actual drilling. The spring stop is inserted in one of the holes in the brass circle, and the work fed up to the drill by means of the tall screw of the back spindle. The drill should have a good speed, and the feeding should be light. If the drill shows any tendency to spring and buckle, a tube of brass may be drilled out by the drill and left upon it, leaving the part through the bar uncovered, of course. This will stiffen the drill very greatly.

One hole having been drilled, return the index plate by withdrawing the spring stop, and allowing the pin to enter the next hole in the brass circle; and so we go on around, drilling each hole in turn until all are drilled.

None of the holes should go through the plate; their depth should be *twice* their diameter.

The same method will be followed in drilling all the holes in the plate. New strips of brass are to be drilled with the number of holes required, the distance between their centers being calculated as in the first case, and new holes drilled in the steel blocks to correspond, and these strips of brass to be fastened upon the wooden disk. This is the *best* way, for the size of the wooden disk then remains the same, and the guiding brass circle remains as large as possible, reducing any error as before mentioned.

The one strip first drilled can, however, be used for all the drilling if so desired. It has only to be cut down to the right number of holes to correspond to the division required, and a new wooden disk fitted to receive the new sized ring thus produced. This constantly reduces the size of the guiding circle, however, and does not serve to diminish error.

It is well to always start the drilling of each circle of holes in the plate upon the same radius. This line can be lightly marked by means of a center square, or in the lathe itself, by using a proper tool, set to exact height of center, in the tool part, and drawing it along by means of the cross feed screw. We then have a means of partially checking the accuracy of the work, for all *even* divisions, such as quarters, eighths, fifths, tenths, etc., etc., of all the numbers divisible by these numbers should fall upon the same radii.

It is not well to try and crowd the circles too closely together; 240 is about as large a number of holes as can well be drilled in a 9 in. plate, and have the holes of a size large enough to be of good service.

NOTE.—The above method is not claimed as original or entirely new. It is a workshop "wrinkle," given me by an old mechanic. Its application is as developed by myself, and will be found to give good results if *careful* work is done. Variations may readily be made to suit particular cases, as best suits the individual.

MAGNESIUM BRONZE.

By H. N. WARREN, Research Analyst.

DURING the past week my attention having been drawn to the manufacture of magnesium bronze, I trust the following details may be observed with interest.

For the production of the various samples two ounces of metallic copper, contained in a graphite crucible, were raised to the melting point by the aid of an injector furnace, and upon its surface was projected half an ounce of magnesium metal; over this, melted borax was poured to prevent oxidation; the magnesium for a few moments burnt with intensity, the reaction quickly subsiding and proceeding tranquilly, emitting at intervals flashes of light characteristic of the metal. The crucible with its contents was now taken from the furnace, allowed to cool, and the metallic button extracted and examined as follows:

The surface having been polished by the aid of fine sand, presented in appearance a highly zinciferous brass; on applying the hammer to the same, the ingot broke into various pieces, even under the influence of a slight stroke, and proved sufficiently brittle to be readily pulverized. Its solubility, oxidizing properties, and fusing point all closely resembled an ordinary brass, the analysis of the alloy showing 11 per cent. magnesium; this was effected by dissolving the metal in nitric acid, precipitating the copper as oxide by means of soda, well washing the precipitate to free it from nitrates, and redissolving in hydrochloric acid, afterward precipitating the whole of the copper by means of metallic magnesium. Washing the reduced copper thus obtained, and drying the same in an atmosphere of hydrogen; after cooling, weighing the metal, and calculating the difference to magnesium.

The remainder of the alloy was remelted with the addition of various percentages of copper, and the former tests applied, the regulus becoming less brittle as the percentage of copper was increased, until an alloy containing 4 per cent. magnesium was obtained, presenting in appearance a true bronze, and resembling the same as regards its physical properties, admitting of either being worked with the saw or readily turned. The experiments were further maintained until 1½ per cent. of magnesium existed; this, although a small percentage, readily affected the copper, both by bleaching and, to a certain extent, hardening the same. In short, the various alloys of copper and magnesium thus produced do not appear to excel, in general properties, the more common and, at the same time, more readily formed alloys of copper.—*Chem. News.*

THE MACARTHUR-FORREST PROCESS FOR THE TREATMENT OF REFRACTORY GOLD ORES.

By WILLIAM JONES.

THIS process depends upon the great chemical affinity of cyanogen for gold and silver, and the ease with which these metals form soluble double cyanides with the alkali metals. Of the common metals gold has the greatest affinity for cyanogen, and their relative affinities are as follows: First, gold; second, silver; third, copper; fourth, zinc; lead, iron, arsenic, antimony, etc., very small.

I do not propose to discuss in this paper the chemical forms in which gold exists in these so-called gold ores; suffice it to say that so great is the affinity of gold for cyanogen that I have yet failed to meet with any ore which did not, on shaking up with even dilute solutions of cyanides, yield up its contents of gold almost entirely to the cyanide solution, and become dissolved as the double cyanide of gold and the alkali used.

The cyanides of the alkali and earthy metals are, practically speaking, the only soluble cyanides, the cheapest and most common being the cyanides of potassium and sodium.

The relative solvent action of these various cyanides on gold and silver compounds, and on the gold and silver compounds existing in ores, has been most carefully and thoroughly investigated by Mr. J. S. Macarthur and Drs. Forrest, who have had a staff of research chemists at work on the subject for nearly three years. It has been found that the cyanides of potassium and sodium are as active in their solvent action as any of the other soluble cyanides.

When ores containing gold, silver, copper, zinc, etc., are treated with solutions of cyanide of potassium or sodium, they are dissolved more or less, forming soluble double cyanides. The solvent action on the base metals can be reduced to a minimum by reducing the strength of the solutions, the readily soluble gold and silver being easily dissolved out with only traces of copper, zinc, etc. The action of these weak cyanide solutions on the metals iron, lead, arsenic, antimony, etc., is practically *nil*, and the solvent action on copper or zinc much depends upon the state of chemical combination in which they exist.

Thus the hydrated oxides and carbonates of copper are more soluble than the sulphides, and the oxide of zinc more soluble than the sulphide of zinc; again, the white sulphide of iron is more soluble than the yellow sulphide.

The best strengths of solutions to use in "leaching" out the gold from these so-called refractory ores depends entirely upon the nature of the ore, and it is impossible to set any hard and fast line. The strength of solutions generally used vary from one-eighth to one per cent. of cyanide of potassium.* The correct strength to use in treating any class or lot of ore may be readily determined by treating a weighed quantity of the ore with varying strengths of cyanide solutions for various periods of time in the laboratory, and analyzing the ore after treatment with the cyanide liquor, and the liquor itself, as to the amount of gold which they contain and the unconsumed cyanide in the liquor, these results being compared with the original contents of gold and silver in the ores, and the original strength in cyanogen of the solution used. (A neat and rapid method of determining the gold in the cyanide liquors is to draw off a known value and evaporate it to dryness over a beaker of water in a capsule shaped out of a piece of silver-free lead foil. The lead foil capsule is then wrapped up in a ball and cupeled in the usual way. The liquor should be as free as possible from base metals. When these are present, the liquor may be boiled to dryness with litharge and the solid residue fused in the usual way for its contents of gold and silver.)

The approximate strength of the solution to use is thus determined, the point aimed at being to reduce the quantity of cyanide actually consumed to a minimum with, at the same time, the highest possible percentage of extraction of the gold and silver.

The process on a large scale is carried out as follows:

The ores (without any previous roasting if sulphur should be present), ground to forty mesh, are placed in pans or wooden vats provided with a stirrer, and to every one ton of the ore there is added about one hundred gallons of water containing one-quarter, one-half, or three-quarters of one per cent. of cyanide of potassium or sodium, or other percentage which experiment in the laboratory shows to be the best approximate strength to use. The whole is then stirred for four to eight hours, the length of time depending upon the nature of the ore. Some ores give better results by grinding in the pan, others require merely agitation with the liquor.

The liquor is run off, carrying with it on an average 85 per cent. of the gold contents of the ore and 80 per cent. of the silver. It is filtered, and the gold and silver in it are precipitated, by passing slowly through zinc turnings, when complete precipitation of the gold and silver takes place. They attach themselves as a loose powder to the zinc, and are easily removed by shaking or stirring, the gold and silver precipitate or sludge falling to the bottom of the vessel, and is removed, dried, and melted in the usual way.

The filtration of the liquor is accelerated by using a vacuum, and there is no practical difficulty about this part of the process, except in the case of ores containing a large percentage of clayey matters. Concentrates work admirably, settling and filtering with the greatest facility.

The action of the cyanide of potassium or sodium upon the metallic zinc is very trifling, exact experiments with accurately weighed quantities of zinc subjected to the action of hundreds of gallons of liquor having proved this, and the complete precipitation of the gold, etc., having also been carefully investigated. The precipitation by zinc is superior to electrical and other methods, and hence is adopted on the large scale.

The amount of free cyanide existing in the liquors after passing through the zinc is then determined by means of a standard solution of nitrate of silver, and the liquor is again made up to its original strength and again used.

The actual consumption of cyanide on the large scale per ton of ore necessarily varies, running from 1½ pounds to 8 pounds per ton. I am, however, of opinion it will average about 5 pounds of cyanide of potash or soda per ton. At the same time I have witnessed ores successfully treated with a consumption of only 1¾ pounds of cyanide per ton, notably a very refractory South African pyrites containing over 3 ounces of gold per ton, the gold extraction being over 90 per cent.

In order to successfully carry out the extraction of the gold from these so-called refractory ores a number of points have to be observed. If the ores contain a noted acidity, due to the presence of basic sulphates of iron, etc. (especially marked in the case of disintegrated and weathered sulphides of the metals), it should be neutralized with the equivalent quantity of caustic lime, in the form of milk of lime. The exact amount of acidity can be readily determined by shaking up a weighed sample of the ore with water and adding standard normal or tenth normal caustic soda solution until the point of akalinity is attained, as determined by litmus or other indicator. The amount of lime required is then easily calculated. Some ores show as much as four per cent. of acidity in terms of soda, and such ores, on treatment with cyanide solutions without previous treatment with lime, show no extraction of their gold contents, whereas, when previously treated with lime, the greater part of the gold was easily extracted. Nearly all sulphides show more or less acidity, but when it is under one-tenth of one per cent. it may, for practical purposes, be neglected.

The cyanide solution used should be as free from caustic alkali (NaHO) (or KHO) as possible, as it is apt to form a sulphide of sodium or potassium with the sulphur of the ores, and thus prevent gold and silver going into solution. This difficulty, when it does occur, is got over by adding chloride of calcium.

The cyanide solutions are best preserved from too great exposure to the air, as a part of the cyanide is apt to be converted by oxidation into the cyanate, an extremely stable compound.

This process is admirably suited for treating iron pyrites containing gold, as no roasting is required, and to ores containing fine or "float," which yield up their gold so easily that they can be treated by merely percolating the cyanide liquor through them. Complex ores containing antimony, arsenic, etc., also yield up their gold contents with great facility. I have had a large number of American and Mexican ores tested by this process, and the average extraction of the gold was 90 per cent. and 85 per cent. of the silver, the percentage of silver extracted being generally less than the gold. Works on this process are now running in New Zealand and Australia, and a plant is about to be erected at the Cape. The process owes much of its success to the skill and untiring efforts of Mr. J. S. Macarthur and Drs. Forrest, and is now the property of a strong company, who have secured patents in all countries of the world.

The cyanide used on the commercial scale is cyanide or mixture of cyanides of potash and soda, made by fusing the yellow ferrocyanide of potassium with a pure soda ash and carbon in an iron pot, at a dull red heat, till the ferrocyanide is decomposed, as ascertained by testing a small sample with an iron salt. The liquid mass is then ladled or run into iron moulds to cool, and the cooled mass forms a black brick containing 75 per cent. of cyanide of potassium and sodium. These bricks are made of a weight of about sixteen pounds each. They are packed in long zinc cases, soldered up and shipped in wooden boxes to the mines or works.

The actual cost of manufacturing such a cyanide is not greater than thirty-five cents per pound. The above method is the old and well-known reaction.

Experiments are now in progress for utilizing the reaction (proposed as early as 1845) of passing nitrogen or furnace gases (free from oxygen) over highly heated alkali and carbon, barium being preferred. From my own experience of this process, on a large scale, I hope to see the cost of the cyanide reduced to at least twenty cents per pound at an early date. I look for an early introduction of this process, on a large scale, into the United States.—*Engineering and Mining Journal.*

* The above strength is on the basis of the cyanogen (C N) found in the sample calculated to K C N. Frequently some of the cyanogen (C N) may exist as Na C N.

THE electric lamp promises to aid in exploring the internal parts of living animals as well as in studying the organic forms of the deep sea.

[Continued from SUPPLEMENT, No. 739, page 11811.]

MAGNETISM.*

By Dr. JOHN HOPKINSON.

No single body is known having the property of capacity for magnetism in a degree which is neither very great nor very small, but intermediate between the two extremes. We can, however, mix magnetic and non-magnetic substances to form bodies apparently intermediate. It is, therefore, interesting to consider what the properties might be of such a mixture. It depends quite as much on the way in which the magnetic part is arranged in the mass as on its actual quantity.

Suppose, for example, it is arranged as in Fig. 4, in threads or plates having a very long axis in the direction of the magnetizing force, we may at once determine the curve of magnetization of the mixture from that of the magnetic substance by dividing the induction for any given force in the ratio of the whole volume to the volume of magnetic substance. If, on the other hand, it is as in Fig. 5—with a very short axis in the direction of the force and a long axis perpendicular thereto—we can equally construct the curve of magnetization.

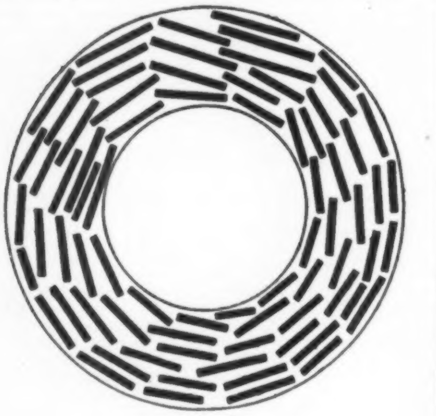


FIG. 4.

This is done in Fig. 6, which shows the curve when nine-tenths of the material is highly magnetic iron arranged as in Fig. 5, while the other curve of the same figure is that when only one-tenth is magnetic, but arranged as in Fig. 4.

You observe how very different is the character of the curve—a difference which is reduced by the much less proportion of magnetic material in the mixture in the one case than in the other. One peculiarity of these arrangements of the two materials in relation to each other is that the resulting material is not isotropic; that is, its properties are not the same in all directions, but depend upon the direction of the magnetizing force in the material.

Of course, this is not at all a probable arrangement, but it is instructive in showing the character of the result as depending upon the construction of the material. Let us, however, consider the simplest isotropic arrangement. Let us suppose that one material is in the form of spheres bedded in a matrix of the other. If the spheres are placed at random, this is clearly an isotropic arrangement. The result is very different according as the matrix or the spheres are of the magnetic material. Suppose that the volume of the spheres is one-half of the whole volume. In Fig. 7 we have approximately the curve for iron, for a mixture of equal quantities of iron and a non-magnetic material, the spheres being non-magnetic and the matrix iron, and for a mixture the spheres being iron and the matrix non-magnetic. Observe the great difference. When the spheres are iron, the induction is near four times the force for all values of the force. When the matrix is iron, the induction is near two-fifths of the induction when the material is iron only.

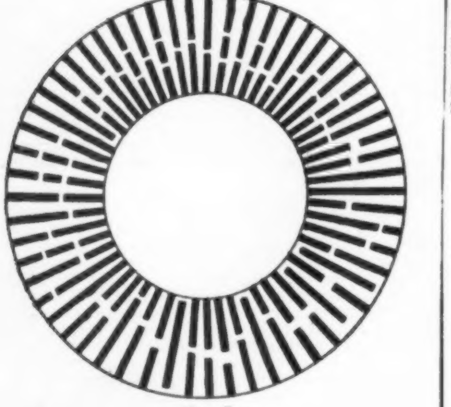


FIG. 5.

In speaking of the properties of bodies which, like manganese steel, are slightly magnetic, it may be well here to enter a caution. But little that is instructive is to be learned by testing filings, or the like, with magnets, as these show but little difference between bodies which are slightly magnetic and those which are strongly magnetic.

Suppose the filings to be spheres, in the following table are given comparative values of the forces they would experience in terms of μ, if placed in a magnetic field of given value, μ having its ordinary signification—that is, being the ratio of the kick on the galvanometer when a ring is tried made of the material of the filing to the kick if the ring is made of a perfectly non-magnetic material:

μ.	Attraction.	
1	0	Non-magnetic body.
1·47	0·18	Manganese steel with 12 per cent.
3·6	1·2	Manganese steel with 9 per cent.
5	1·5	
10	2·1	
100	2·8	
1,000	2·98	

Now the bodies in which μ is so small as 3·6 belong distinctly to the non-magnetic class; but the test with the magnet would very markedly distinguish them

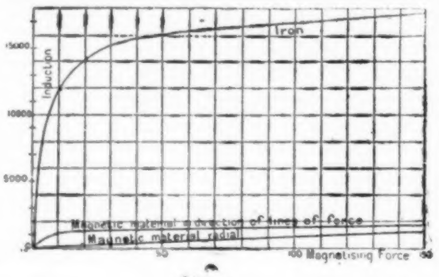


FIG. 6.

from manganese steel with 12 per cent. of manganese. The distinction, however, between $\mu = 3·6$ and $\mu = 1{,}000$ is comparatively small; whereas, under the conditions of experiment, μ is much more than 1,000 for most bodies of which iron is the principal constituent.

The effects of stress on the magnetic properties of iron and nickel have been studied by Sir W. Thomson. A fact interesting from a broad and general point of view is that the effects of stress are different in kind in the case of iron and nickel. In the case of iron, for small magnetizing forces in the direction of the tension, tension increases the magnetization: for large forces, diminishes it. In the case of nickel, the effect is always to diminish the magnetization.

When one considers that the magnetic property is peculiar to three substances, that it is easily destroyed by the admixture of some foreign body, as manganese, one would naturally expect that its existence would depend also on the temperature of the body. This is found to be the case.

It has long been known that iron remains magnetic to a red heat, and that then it somewhat suddenly ceases to be magnetic, and remains at a higher temperature non-magnetic. It has long been known that the same thing happens with cobalt, the temperature of change, however, being higher; and with nickel, the temperature being lower. The magnetic characteristics of iron at a high temperature are interesting.

Let us return to our ring, and let us suppose that the coils are insulated with a refractory material, such as asbestos paper, and that the ring is made of the best soft iron. We are now in a position to heat the ring to a higher temperature, and to experiment upon it at high temperatures in exactly the same way as before.

The temperature can be approximately determined by the resistance of one of the copper coils.

Suppose, first, that the current in the primary circuit which we use for magnetizing the ring is small; that from time to time, as the ring is heated and the temperature rises, an experiment is made by reversing the current in the primary circuit and observing the deflection of the galvanometer. At the ordinary temperature of the air the deflection is comparatively small; as the temperature increases the deflection also increases, but slowly at first; when the temperature, however, reaches something like 600° C., the galvanometer deflection begins very rapidly to increase, until, with a temperature of 770° C., it attains a value of no less than 11,000 times as great as the deflection would be if the ring had been made of glass or copper, and the same exciting current had been used.

Of course, a direct comparison of 11,000 to 1 cannot be made; to make it we must introduce resistance into the secondary circuit when the iron is used; and we must, in fact, make use of larger currents when copper is used.

However, the ratio of the induction in the case of iron to that in the case of copper, at 770° C., for small forces is no less than 11,000 to 1.

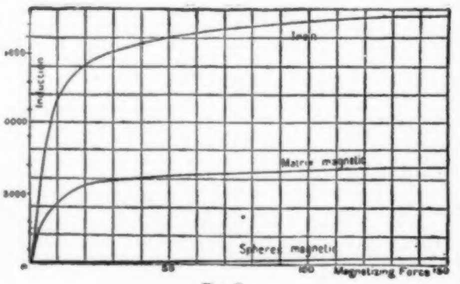


FIG. 7.

Now mark what happens. The temperature rises another 15° C.; the deflection of the needle suddenly drops to a value which we must regard as infinitesimal in comparison to that which it had at a temperature of 770° C.; in fact, at the higher temperature of 785° C. the deflection of the galvanometer with iron is to that with copper in a ratio not exceeding that of 1·14 to 1. Here, then, we have a most remarkable fact—at a temperature of 770° C. the magnetization of iron 11,000 times as great as that of a non-magnetic substance; at a temperature of 785° C. iron practically non-magnetic. These changes are shown in Fig. 8.

Suppose, now, that the current in the primary circuit, which serves to magnetize the iron, had been great instead of very small. In this case we find a very different order of phenomena. As the temperature rises, the deflection on the galvanometer diminishes very slowly till a high temperature is attained. Then the rate of decrease is accelerated until, as the temperature at which the sudden change occurred for small forces is reached, the rate of diminution becomes very rapid indeed, until, finally, the magnetism of the iron disappears at the same time as for small forces. Instead of following the magnetization with constant forces for varying temperatures, we may trace the curve of magnetization for varying forces with any temperature we please.

Such curves are given in Diagrams 9 and 10. In the

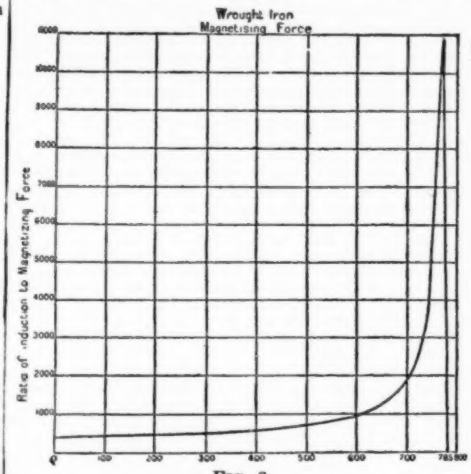


FIG. 8.

one diagram, for the purpose of bringing out different points in the curve, the scale of abscissæ is twenty times as great as in the other.

You will observe that the effect of rise of temperature is to diminish the maximum magnetization of which the body is capable, slowly at first, and rapidly at the end. It is also very greatly to diminish the coercive force, and to increase the facility with which the body is magnetized. To give an idea of the magnetizing forces in question, the force for Fig. 8 was 0·3; and as you see from Figs. 9 and 10, the force ranges as high as 60.

Now the earth's force in these latitudes is 0·43, and the horizontal component of the earth's force is 0·18. In the field of a dynamo machine the force is often more than 7,000. In addition to the general characteristics of the curve of magnetization, a very interesting and, as I take it, a very important fact comes out. I have already stated that if the ring be submitted to a great current in one direction, which current is after-

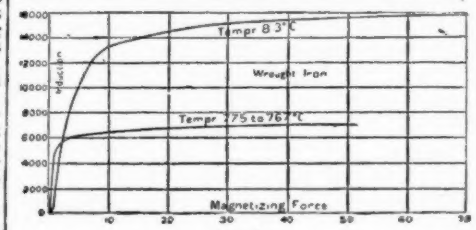


FIG. 9.

ward gradually reduced to zero, the ring is not in its non-magnetic condition, but that it is, in fact, strongly magnetized.

Suppose, now, we heat the ring, while under the influence of a strong magnetizing current, beyond the critical temperature at which it ceases to have any magnetic properties, and that then we reduce the current to zero, we may in this state try any experiment we please. Reversing the current on the ring, we shall find that it is in all cases non-magnetic.

Suppose next that we allow the ring to cool without any current in the primary, when cold we find that the ring is magnetized; in fact, it has a distinct recollection of what had been done to it before it was heated to the temperature at which it ceased to be magnetic. When steel is tried in the same way with varying temperatures, a similar sequence of phenomena is observed; but for small forces the permeability rises to a lower maximum, and its rise is less rapid. The critical temperature at which magnetism disappears changes rapidly with the composition of the steel.

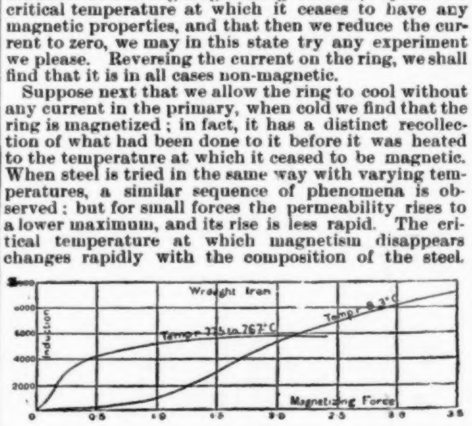


FIG. 10.

For very soft charcoal iron wire the critical temperature is as high as 880° C.; for hard Whitworth steel it is 690° C.

The properties of an alloy of manganese and iron are curious. More curious are those of an alloy of nickel and iron. The alloy of nickel and iron containing 25 per cent. of nickel is non-magnetic as it is sure to come from the manufacturer; that is to say, a substance compounded of two magnetic bodies is non-magnetic. Cool it, however, a little below freezing, and its properties change; it becomes very decidedly magnetic. This is perhaps not so very remarkable; the nickel steel has a low critical temperature—lower than we

* Recent inaugural address as president of the Institution of Electrical Engineers, London.

have observed in any other magnetizable body. But if now the cooled material be allowed to return to the ordinary temperature it is magnetic; if it be heated it is still magnetic, and remains magnetic till a temperature of 580° C. is attained, when it very rapidly becomes non-magnetic, exactly as other magnetic bodies do when they pass their critical temperature. Now cool the alloy: it is non-magnetic, and remains non-magnetic till the temperature has fallen to below freezing. The history of the material is shown in Fig. 11, from which it will be seen that from — 20° C. to 580° C. this alloy may exist in either of two states, both quite stable—a magnetic and a non-magnetic—and that the state is determined by whether the alloy has been last cooled to — 20° C. or heated to 580° C.

Sudden changes occur in other properties of iron at

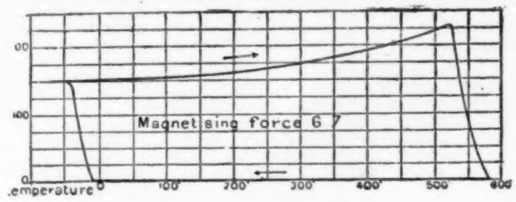


FIG. 11.

this very critical temperature at which its magnetism disappears. For example, take its electrical resistance. On the curve, Fig. 12, is shown the electrical resistance of iron at various temperatures; and also the electrical resistance of copper or other pure metal. Observe the difference. If the iron is heated, its resistance increases with an accelerating velocity, until, when near the critical temperature, the rate of increase is five times as much as the copper; at the critical temperature the rate suddenly changes, and it assumes a value which, as far as experiments have gone, cannot be said to differ very materially from a pure metal. The resistance of maganese steel shows no such change. Its temperature coefficient constantly has the value of 0·0012, which it has at the ordinary temperature of the air. The electrical resistance of nickel varies with temperature in an exactly similar manner.

Again, Prof. Tait has shown that the thermo-electric properties of iron are very anomalous, that there is a sudden change at or about the temperature at which the metal becomes non-magnetic, and that before this temperature is reached the variations of thermo-electric property are quite different from a non-magnetic metal.

Prof. Tomlinson has investigated how many other properties of iron depend upon the temperature. But the most significant phenomenon is that indicated by the property of recalescence. Prof. Barrett, of Dublin, observed that if a wire of hard steel is heated to a very bright redness, and is then allowed to cool, the wire will cool down till it hardly emits any light at all, and that then it suddenly glows out quite bright again, and afterward finally cools. This phenomenon is observed with great difficulty in the case of soft iron, and is not observed at all in the case of manganese steel. A fairly approximate numerical measurement may be made in this way: Take a block of iron or steel on which a groove is cut, and in this groove wind a coil of copper wire insulated with asbestos; cover the coil with many layers of asbestos; and finally cover the whole lump of iron or steel with asbestos again. We have now a body which will heat and cool comparatively slowly, and which will lose its heat at a rate very approximately proportional to the difference of temperature between it and the surrounding air. Heat the block to a bright redness, and take it out of the fire and observe the resistance of the copper coil as the temperature falls, due to the cooling of the block. Plot a curve in which the abscissæ are the

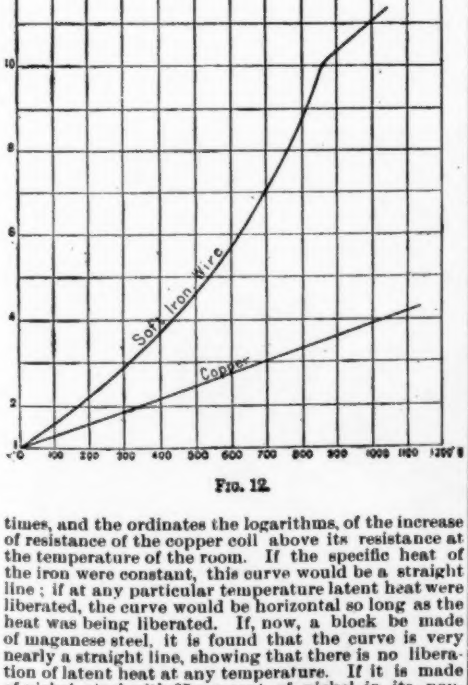


FIG. 12.

times, and the ordinates the logarithms, of the increase of resistance of the copper coil above its resistance at the temperature of the room. If the specific heat of the iron were constant, this curve would be a straight line; if at any particular temperature latent heat were liberated, the curve would be horizontal so long as the heat was being liberated. If, now, a block be made of maganese steel, it is found that the curve is very nearly a straight line, showing that there is no liberation of latent heat at any temperature. If it is made of nickel steel with 25 per cent. of nickel in its non-magnetic state, the result is the same—no sign of liberation of heat. If, now, the block be made of hard steel, the temperature diminishes at first; then the curve (Fig. 13) which represents the temperature bends round; the temperature actually rises many degrees while the body is losing heat. The liberation of heat being completed, the curve finally descends as a straight line. From inspection of this curve it is apparent why hard steel exhibits a sudden accession of brightness as it yields up its heat. In the case of soft iron the temperature does not actually rise as the body loses heat, but the curve remains horizontal, or nearly horizontal, for a considerable time. This, again, shows why, although a considerable amount of heat is liberated at a temperature corresponding to the horizontal part of the curve, no marked recalescence can be obtained. From curves such as these it is easy to calculate the amount of heat which becomes latent. As the iron passes the critical point it is found to be about 200 times as much heat as is required to raise the temperature of the iron 1 degree C. From this we get a very good idea of the importance of the phenomenon. When ice is melted and becomes water, the heat absorbed is 80 times the heat required to raise the temperature of the water 1 degree C., and 160 times the heat required to raise the temperature of the ice by the same amount. The temperature of recalescence has been abundantly identified with the critical temperature of magnetism.* I am not aware that anything corresponding with recalescence has been observed in the case of nickel. Experiments have been tried, and gave a negative result, but the sample was impure; and the result may, I think, be distrusted as an indication of what it would be in the case of pure nickel. The most probable explanation in the case of iron, at all events, appears to be that when iron passes from the magnetic to the non-magnetic state it experiences a change of state of comparable importance with the change from the solid to the liquid state, and that a large quantity of heat is absorbed in the change. There is, then, no need to suppose chemical change; the great physical fact accompanying the absorption of heat is the disappearance of the capacity for magnetization.

What explanations have been offered of the phenomena of magnetism? That the explanation must be molecular was early apparent. Poisson's hypothesis was that each molecule of a magnet contained two magnetic fluids, which were separated from each other under the influence of magnetic force. His theory explained the fact of magnetism induced by proximity to magnets, but beyond this it could not go. It gave no hint that there was a limit to the magnetization of iron, a point of saturation, none of hysteresis, no hint of any connection between the magnetism of iron and any other property of the substance, no hint why magnetism disappears at a high temperature. It does, however, give more than a hint that the permeability of iron could not exceed a limit much less than its actual value, and that it should be constant for the material, and independent of the force applied. Poisson gave his theory a beautiful mathematical development, still useful in magnetism and in electrostatics.

Weber's theory is a very distinct advance on Poisson's. He supposed that each molecule of iron was a magnet with axes arranged at random in the body; that under the influence of magnetizing force the axes of the little magnets were directed to parallelism in a greater degree as the force was greater. Weber's theory thoroughly explains the limiting value of magnetization, since nothing more can be done than to direct all the molecular axes in the same direction. As modified by Maxwell, or with some similar modification, it gives an account of hysteresis, and of the general form of the ascending curve of magnetization. It is also very convenient for stating some of the facts. For example, what we know regarding the effect of temperature may be expressed by saying that the magnetic moment of the molecule diminishes as the temperature rises, hence that the limiting moment of a magnet will also diminish; but that the facility with which the molecules follow the magnetizing force is also increased, hence the great increase of μ for small forces, and its almost instantaneous extinction as the temperature rises. Again, in terms of Weber's theory, we can state that rise of temperature enough to render iron non-magnetic will not clear it of residual magnetism. The axes of the molecules are brought to parallelism by the force which is impressed before and during the time that the magnetic property is disappearing; they remain parallel when the force ceases, though, being now non-magnetic, their effect is *nil*. When, the temperature falling, they become again magnetic, the effect of the direction of their axes is apparent. But Weber's theory does not touch the root of the matter by connecting the magnetic property with any other property of iron, nor does it give any hint as to why the moment of the molecule disappears so rapidly at a certain temperature.

Ampere's theory may be said to be a development of Weber's; it purports to state in what the magnetism of the molecule consists. Associated with each molecule is a closed electric current in a circuit of no resistance; each such molecule, with its current, constitutes Weber's magnetic molecule, and all that it can do they can do. But the great merit of the theory—and a very great one it is—is that it brings magnetism in as a branch of electricity; it explains why a current makes a magnetizable body magnetic. It also gives, as extended by Weber, an explanation of diamagnetism. It, however, gives no hint of connecting the magnetic properties of iron with any other property.

Another difficulty is this: When iron ceases to be magnetizable, we must assume that the molecular currents cease. These currents represents energy. We should therefore expect that, when iron ceased to be magnetic by rise of temperature, heat would be liberated; the reverse is the fact.

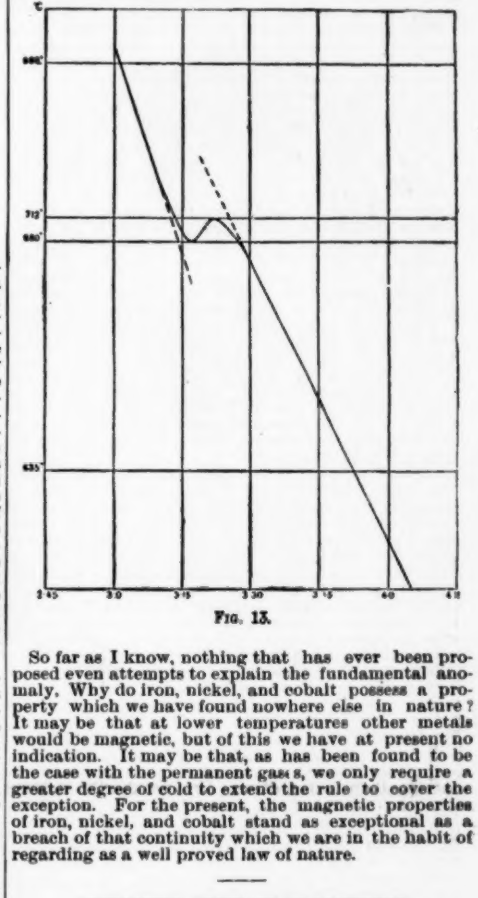


FIG. 13.

So far as I know, nothing that has ever been proposed even attempts to explain the fundamental anomaly. Why do iron, nickel, and cobalt possess a property which we have found nowhere else in nature? It may be that at lower temperatures other metals would be magnetic, but of this we have at present no indication. It may be that, as has been found to be the case with the permanent gases, we only require a greater degree of cold to extend the rule to cover the exception. For the present, the magnetic properties of iron, nickel, and cobalt stand as exceptional as a breach of that continuity which we are in the habit of regarding as a well proved law of nature.

AUTHORIZED ABSTRACT OF DISCUSSION.

Sir William Thomson said the president had done well to emphasize the marvelous properties of iron, nickel, and cobalt, but he thought these properties were not quite so much isolated as would appear from the address. Faraday showed the continuity between paramagnetic and diamagnetic bodies, and that all substances are susceptible to magnetism when subjected to sufficiently intense magnetizing forces. He had also compared the relative susceptibilities of materials, such as glass, bismuth, wood, etc., but the absolute determination of their susceptibilities still presents a large field for interesting and valuable research. The fact that the magnetic properties of such substances could be compared was itself of immense importance, while Tyndall's observations on the properties of bread, Iceland spar, etc., which can be made, or are naturally, magnetically aniostropic, further enhances the interest connected with the subject. The prodigious difference between the magnetic properties of iron, nickel, and cobalt and those of other substances, the speaker considered to be one of the great marvels of nature, and many ideas had been suggested by the president's address, which so forcibly emphasized these great distinctions. Referring to the absence of deflection of the ballistic galvanometer when a copper core is withdrawn from a coil, he said this does not prove that no effect takes place in the copper during the process, for in reality two equal and opposite effects occur in rapid succession, thus neutralizing each

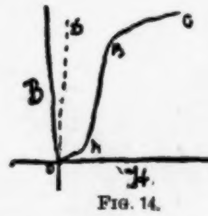


FIG. 14.

other's influence on the slow-moving needle. In iron, however, in addition to these induced currents in the metal itself, a change in the induced magnetism makes itself evident by a throw of the needle. The fact that a current or magnet when placed near iron exerts a permanent influence on the iron, whereas no such effect is produced on copper or non-magnetic bodies, always seemed to him a marvelous difference. As regards the president's remark that Poisson's theory gave no hint of hysteresis, this, he thought, was open to question, for the theory refers to coercive force, and this is hysteresis under another name. Coming to the subject of recalescence, Sir William said this was of im-

* I have only recently become acquainted with the admirable work of M. Osmond on recalescence. He has examined a great variety of samples of steel, and determined the temperatures at which they give off an exceptional amount of heat. Some of his results are apparent on my own curves, though I had assumed them to be mere errors of observation. For example referring to my Royal Society paper, there is, in Fig. 38, a hint of a second small anomalous point a little below the larger one. And, comparing Fig. 38 and 38A, we see that the higher the heating, the lower is the point of recalescence; both features are brought out by M. Osmond. The double recalescence observed by M. Osmond in steel with a moderate quantity of carbon I would explain provisionally by supposing this steel to be a mixture of two kinds which have different critical temperatures. Although M. Osmond's method is admirable for determining the temperature of recalescence, and whether it is a single point or multiple, it is not adapted to determine the quantity of heat liberated, as the small sample used is inclosed in a tube of considerable mass, which cools down at the same time as the sample experimented upon.

mense importance, and one of the wonders duly accentuated by the president. In this connection he wished to add that most of the work on the latent heat of iron about the temperature at which recalescence occurs had been done by the president himself. The region about the ripple in Fig. 13 requires further investigation, and, if possible, a cycle, such as Andrews used in his experiments on evaporation and condensation, should be devised. The material exists in two or more different states at the same temperature, and if the effect is reversible, then the iron should cool while heat is being supplied to it. In conclusion, Sir William suggested that several physical properties of the material should be tested statically while it was kept at temperatures little above and little below the critical one, and also during the various states in which the material exists at the same temperature.

Prof. Ewing said he was glad to congratulate the society on being favored with such a valuable address, for he was sure that it had been no less interesting to those little acquainted with the subject than to those familiar with recent researches. He himself was particularly interested in the matter, and was surprised that all the facts relating to magnetization had been so clearly stated without using the word "susceptibility," or the expression "intensity of magnetization." Commenting on the enormous amount of hysteresis exhibited by the alloy of nickel and iron (Fig. 11), Prof. Ewing said he had looked for hysteresis in similar alloys and had found none; now he saw why he found none, for his experiments were made between ordinary atmospheric temperatures and 212 degrees F., while Dr. Hopkinson, by increasing the range of temperature, had passed the critical points, and shown the hysteresis to be very great. One other point he wished to mention in connection with a probable instability which exists when iron is subjected to small magnetizing forces. Take the ordinary curve of magnetization, this may be divided into three portions, O A, A B, BC (see Fig. 14). The part O A had been shown by Lord Rayleigh to be a straight line, and he (the speaker) found that in a true magnetization curve, where the condition of endlessness was perfectly satisfied, the part A B should be vertical or nearly so. His own experiments were made on rods from 300 to 400 diameters long, and on treating these mathematically as ellipsoids, he found that the magnetizing forces, H, should be measured from a line O D, which is practically parallel to A B. A similar result had quite recently been obtained by Mr. Nagaroka, who, in some experiments on the magnetization of nickel when subjected to mechanical stresses, had succeeded in lengthening the part O A considerably, and then found A B to be practically vertical. In his own (Prof. Ewing's) experiments on iron he found that by tapping a rod while subjected to magnetizing force, a permeability of 20,000 could be obtained.

ANEURISM OF SCALP.

By Herman Mynter, M.D., of Buffalo, Professor of Surgery, Niagara University.

Mrs. D., æt. 43 years, entered the Buffalo Hospital of the Sisters of Charity, October 19, 1889, with the following history: The patient was formerly greatly addicted to drink. Eight years ago, while in a drunken fit, she was making a great deal of noise and yelling murder. She was forced to the floor, and to stop her noise, received a slight slap in the face. When she recovered from the effects of the liquor, her right forehead was reddish and the arteries in that region were pulsating more than normal. This increased until the present time and she now presents the following symptoms:

The right temporal artery, and particularly its anterior branch, is greatly enlarged, extending in a tortuous way over the forehead. Here and there circumscribed dilatations are seen, some as large as a hickory nut. Left temporal artery similarly affected, although in a slighter degree. Over and anterior to the right ear is seen a rather large pulsating tumor, formed from anastomoses with the posterior auricular and the temporalis media artery. A similar but smaller tumor is seen over the right eyebrow, formed from anastomosis with the superior orbital artery. The right cheek has a nævus-like appearance, the conjunctiva of right eye is diffusely red from enlarged vessels. During the whole length of the tortuous arteries grooves are felt in the bone, corresponding to the size of the artery and produced by absorption of bone on account of the pulsation.

The absorption of bone seems here and there almost to have gone through the internal table. A distinct thrill is felt everywhere and with the stethoscope a distinct loud aneurismal murmur is heard, which disappears by pressure on external carotis. The patient complains of heat and fullness in the face and of a loud pounding sound, when she lies down, also of frequent profuse hæmorrhages from the right nostril. Her reddish, swollen face gives her such an appearance that she scarcely ever is willing to leave her house in daytime. Otherwise she is in a healthy condition and has not drank any liquor for the last year.

Under ether narcosis the right external carotid artery was ligated under the posterior belly of the digastric muscle. The murmur and thrill immediately disappeared. The left temporal and the enlarged arteries were thereafter ligated subcutaneously in eleven places

Figs. 1 and 2.—CIRSOID ANEURISM OF SCALP; CONDITION PREVIOUS TO OPERATION.

with antiseptic silk ligatures, which were introduced under the arteries by aid of a sharp-pointed, curved Hagedorn's needle. The silk ligatures were thereafter tied over pieces of thick drainage tubes. The field of the operation was profusely dusted with iodoform and dressed antiseptically. The first dressing was removed seven days later.

The wound over the carotis externa was found healed by first intention. Over the whole forehead a remarkable change had taken place, the redness had disappeared, the conjunctiva was almost white, and the arteries had more or less disappeared. On no point had the subcutaneous sutures produced inflammation or sloughing. The drainage tubes were seen almost buried in deep grooves of the skin, but by lifting up their ends, the underlying skin was seen healthy. They were therefore left in their places for a week longer and then removed. Three enlarged but not pulsating arteries in front of right ear were then similarly ligated and the ligatures kept in place for eleven days. The patient left the hospital November 9, with scarcely any traces of her disease, no thrill or murmur, with white cornea and white forehead, and she may now, December 1, be considered perfectly recovered.—*Annals of Surgery.*

[New Orleans Medical and Surgical Journal.]

OLIVE OIL FOR SNAKE BITES.

I read with pleasure the correspondence of Dr. S. C. Harvy, of Alabama, on the use of bicarbonate of soda for the bites of snakes and insects. I never used the soda in snake bites, but have for many years used it in the bites of insects and the stings of bees, and it has always proved a sure remedy in those cases.

I have never used any other treatment for snake bite than olive oil. It has given in all cases prompt relief; always a sure and perfect cure. My first case was on July 27, 1850, in Elk county, Penn. A boy about 10 years old was bitten by rattlesnake while out with his father picking huckleberries. The father carried the boy home on his back, and sent for me. Remembering what Gibson said as to the use of olive oil in snake bites, I placed a large bottle of pure virgin olive oil in my satchel and visited the boy, and found his entire body, head, face, and limbs terribly swollen, and the tongue protruding from the mouth; could not swallow. I at once filled a tablespoon with olive oil, and placing the spoon in the mouth with much trouble and effort, pressed it back to the back part of the tongue, and the patient swallowed the oil. I then scarified the wound, and packed it with olive oil, and then gave more oil by the mouth, which he swallowed more easily. I thus gave the oil in tablespoonful doses till I had given six spoonfuls, when my patient became quiet, breathed easily, and could swallow without any trouble. The patient was soon discharged perfectly well, and lives at this time a healthy farmer. I never used any other treatment for the bite of snakes than olive oil, externally and internally. Since that time my practice has been very extensive in the counties of Elk, Clinton, Cameron, Clearfield, along the creeks and rivers; also skirts of the Alleghenies.

I have treated many cases and have a record of twenty-five very bad cases, all of which were treated by the free use of olive oil internally and externally. I have never used or directed any other treatment. The inhabitants of locations where rattlesnakes and copperheads are found always keep a good supply of olive oil in their houses, and when bitten never call a doctor, but use olive oil freely, which in every case gives full and complete relief. Therefore, my experience for the past thirty-nine years has fully proved the correctness of the treatment with olive oil of Dr. Miller, of South Carolina.

I will here quote from William Gibson, M.D., late professor of surgery in the University of Pennsylvania (See Gibson's Surgery, vol. 1, p. 88): "The use of olive oil has been highly extolled by many writers as a remedy for the bites of poisonous serpents."

Dr. Miller, of South Carolina, relates the case of a man who was bitten in the sole of the foot by a very large rattlesnake. Although very little time elapsed before he reached the patient, "his head and face were prodigiously swelled, and the latter black. His tongue was enlarged and out of his mouth; his eyes as if starting from their sockets; his senses gone and every appearance of immediate suffocation. Two tablespoonfuls of olive oil were immediately given and gotten down, but with great difficulty. The effect was almost instantaneous; in thirty minutes it operated freely by the mouth and bowels, and in two hours the patient could articulate, and soon after recovered. The quantity of oil taken internally and applied to the wound did not exceed eight spoonfuls." In the course of twelve years Dr. Miller has met with several similar cases, in which the oil has proved equally successful. Olive oil has been used for various medicinal purposes in all ages. It was mentioned by Monsieur Pomit, chief druggist to the late French king, Louis XIV., to which he adds his father's observations, fourth edition, 1748. He says: "It is a natural balsam for the cure of wounds, being beat up with wine. It is of wine and this oil that the Samaritan balsam, with which the Good Samaritan in the Gospel healed the wounds of the traveler, was made, and it is a medicine in use at this day." It was and is now freely used internally in many cases with marked success. I also use it with marked success in catarrh of the stomach and bowels; also in gall stones, and find it of great use in diseases of the rectum, etc. C. R. Earley, M.D.

Ridgway, Pa., Dec. 7, 1889.

TREATMENT OF BARBER'S ITCH.

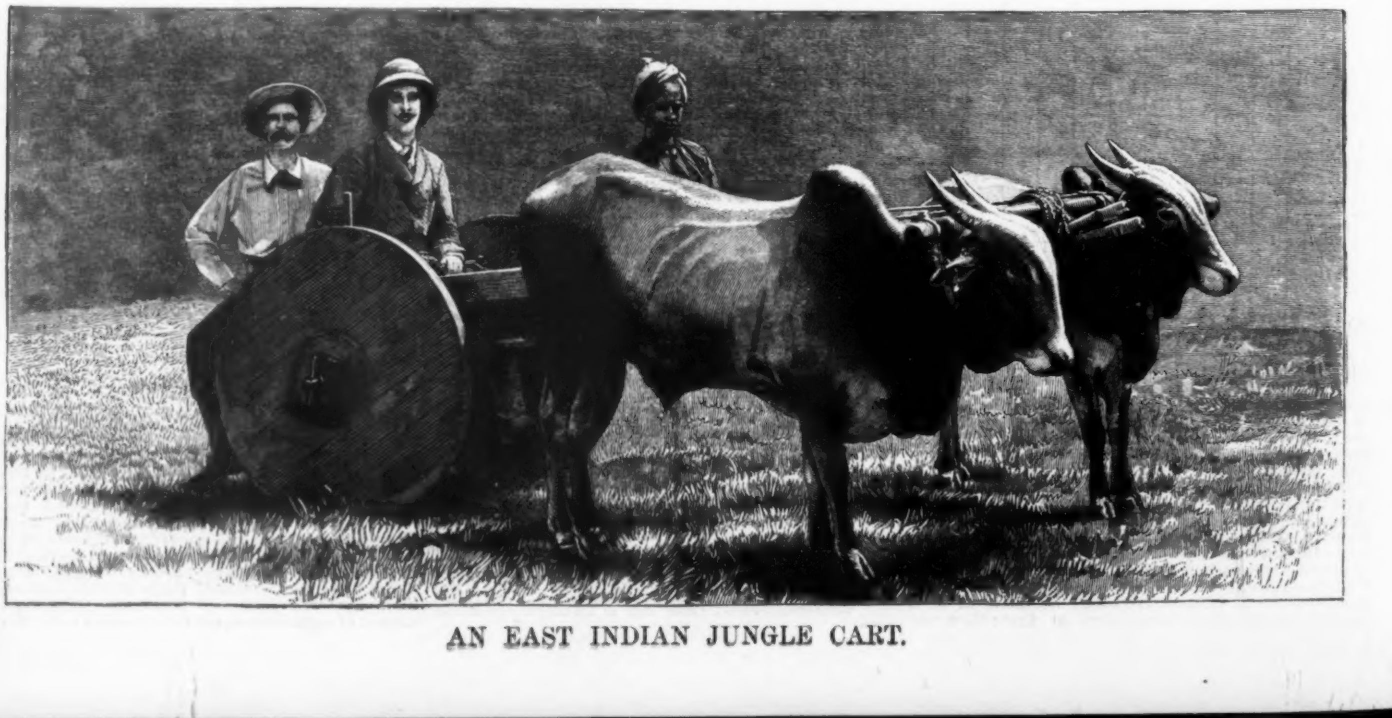
Dr. Rosenthal orders the seat of the affection to be closely shaved daily, and the following ointment to be rubbed in twice a day:

℞.	Acid. tannic..................	grs. xlv.
	Lact. sulph....................	ʒ jss.
	Zinc. oxid.	
	Amyl.......................āā	ʒ iv.
	Vaselini......................	℥ j.
M.	Sig.: To be used twice daily.	

In a month nothing remains of the eruption but a very slowly disappearing erythema.

A JUNGLE CART.

The engraving represents Prince Albert seated by the side of Mr. Sanderson in a primitive jungle carriage, drawn by a pair of oxen. This sort of carriage is called a "woddur;" it is used by the ryots in their husbandry work, and is very simply constructed. The wheels are of solid sections of wood, and the axle is also of wood, so that any clever forester by the aid of his ax can put together a vehicle which is much better suited for jungle purposes than the most elaborate structure composed by the coach builder in civilized life.—*Graphic.*



AN EAST INDIAN JUNGLE CART.

THE JAPANESE PUZZLE.

THE Chinese puzzle, so popular half a century ago, and now fallen into desuetude, consisted of a small number of geometrical figures (squares, triangles, lozenges, etc.) cut out of thin wood, ivory, or mother of pearl. The box containing the game was accompanied with two small books. In one of these, outline drawings represented, by their external contours only, the hundreds of figures that it was possible to obtain through the juxtaposition of the pieces in various ways. The second book contained a solution of the various problems laid down in the first, under the form of figures indicating the position of each piece.

Despite the infinite number of ingenious combinations that it was possible to make, the game became monotonous.

On examining the figures herewith presented, our readers will doubtless judge that it is entirely different with the new kind of puzzle that Mr. Fouji, a Japanese artist, has devised for their amusement.

The constituent elements, represented isolatedly to the right of the engravings, are cut out of dark paper. It will be remarked that their contours are determined by straight lines and ovals or ellipses all capable of being drawn by means of a ruler and compasses. These various elements, the grouping of which will give the profiles of the animals shown in Figs. 1 and 2, are produced solely by the processes of linear drawing, and a knowledge of artistic drawing is not necessary in forming them.

In two of the figures of the model in Fig. 1, the place of each of the pieces is shown by dotted lines. By a little research, it will be easy to find their position in the two other figures. By a little exercise of the imagination and taste other profiles may be formed.

Contrary to what is required in the Chinese puzzle, it is not indispensable here to employ all the pieces. Thus, the two small circles that represent eyes, and that are placed on the two sides of the bird's head when it is seen from above, are no longer necessary in

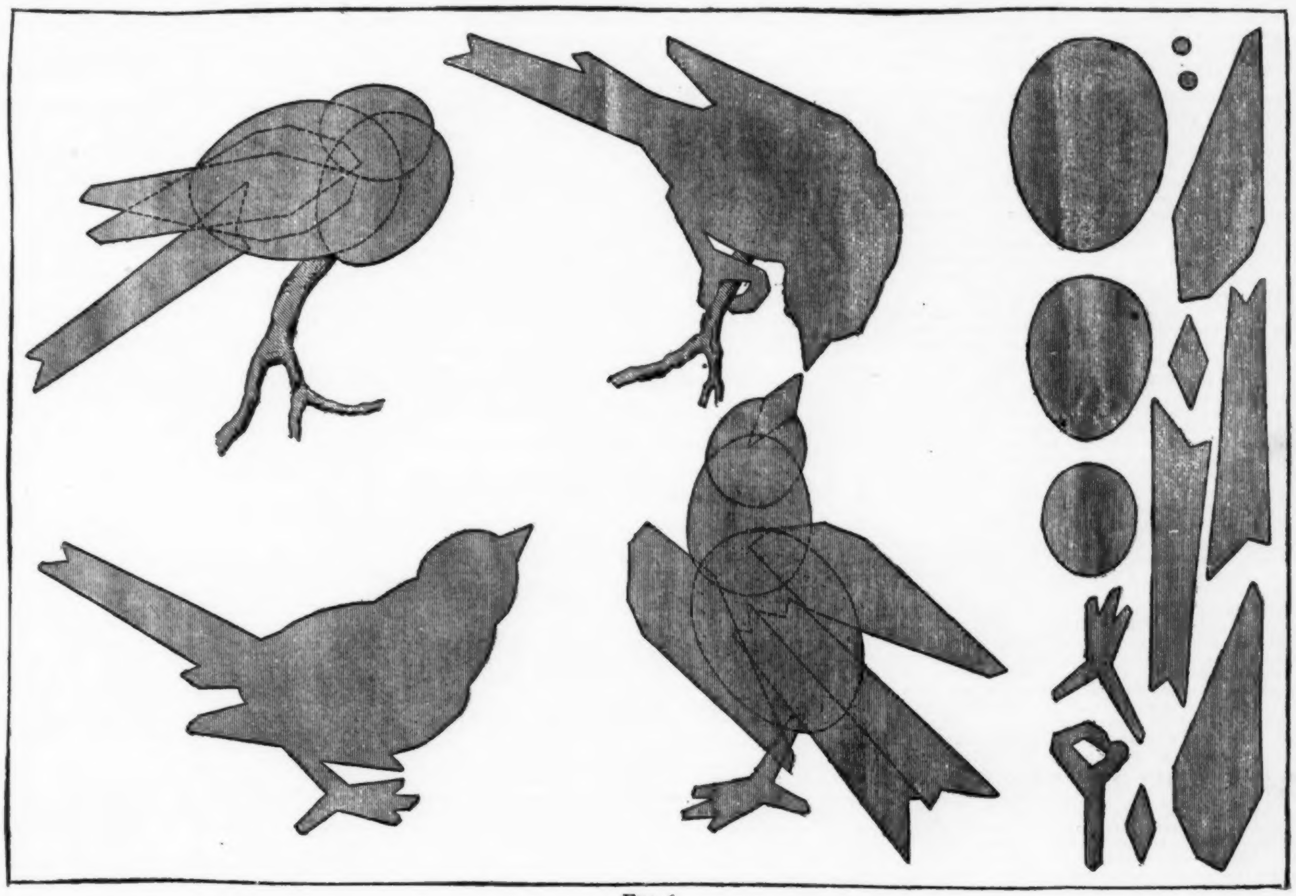


FIG. 1.

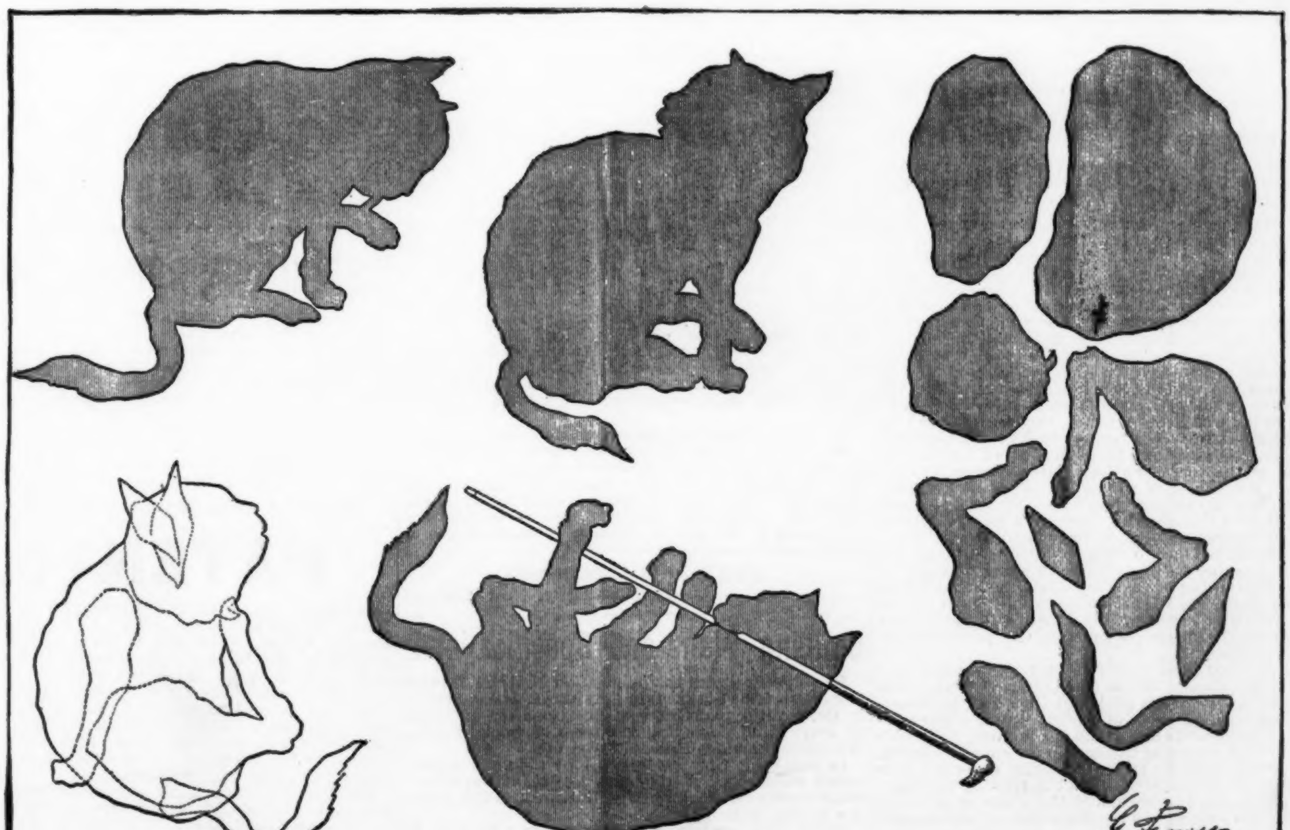


FIG. 2.

JAPANESE PUZZLE.

the other positions, as, for example, when it is desired to represent the bird asleep with its head under its wing. The same is the case with the lozenges representing the bill. The sharpest will serve to represent the pointed bill of the nightingale, warbler, or other insectivorous singers, while the artist has reserved the obtusest lozenge for thicker bills, such as the bill of the canary and sparrow. The closed foot is used for the profile of the bird perched upon a branch; and the foot with outspread toes for the bird walking upon the ground.—*La Science Illustrée.*

NATIVE WYOMING SOAP.

By HERMAN WESTPHAL, Ph.G.

THIS mineral, which is known locally under the name of "Native Wyoming Soap," occurs in the Blue Ridge, 30 to 40 miles west and southwest of Soudance, Wyoming Territory, at an elevation of about 5,000 feet.

It is found in two distinct forms. 1. The wet variety, which occurs in sink holes, or in the neighborhood of springs, and covers, probably, an area of several hundred acres. It forms a thick, very tenacious pasty mass, about the consistency of butter. Its color is light yellowish gray. Taste slightly saline, clay-like. Odor argillaceous. Moistened between the fingers with a little water, it feels like soap or some greasy substance. Hence its name. This soapy feel is probably due to the extreme fineness of the silicates which it contains. In hot weather the edges of the sink holes become hard and brittle, and on some places show an efflorescence of fine crystals of magnesium sulphate.

These holes, which seem to be almost bottomless, at times become very annoying to the ranches, as cattle frequently get into them, and unless discovered in time and pulled out are sure to perish, as it is impossible for them to free themselves.

2. The dry variety occurs underground in veins like coal. It is hard and dry, and looks very much like chalk; the color is somewhat darker, varying from yellowish white to dirty greenish yellow. On addition of a little water, however, it is converted into the soft variety as found on the surface of the earth. It appears probable that the wet variety is formed by springs running over beds of dry soap, washing it up and in time accumulating it in large quantities.

It is used by cowboys and ranchers who live in the vicinity as a substitute for soap and for removing grease by absorption. They also use it for making "hard water."

Five grammes of the soap exposed to the atmosphere for several weeks at a temperature of about 24° C. lost 41·20 per cent. of moisture. It had become a very hard and brittle mass, varying from dirty white, grayish green to orange yellow. Taste and color were unaltered; it adhered to the tongue, and when cut with a knife exhibited a very smooth and shining surface. On ignition the wet soap lost 53·30 per cent., while the air-dry soap lost 12·10 per cent., corresponding to 41·20 per cent. on exposure. The air-dry soap reduced to an impalpable powder gave the following composition on analysis:

	Per cent.
SiO_2	61·08
Fe_2O_3	3·91
Al_2O_3	17·12
MnO	traces.
CaO	2·76
MgO	1·82
Na_2O	0·20
SO_3	0·88
H_2O	12·10
Total	99·87

—*Am. Jour. Pharm.*

DETECTING TIN IN MINERALS.

By ALEXANDER JOHNSTONE, F.G.S. (London and Paris), Assistant to Professor of Geology and Mineralogy in the University of Edinburgh.

MINERALS containing tin yield, when mixed with fluxes and properly heated for some time before the blowpipe on charcoal in a good strong reducing flame, malleable metallic globules of a high luster and silver white color. For the reduction of the ores of tin and most of the other minerals known to contain that metal, the common white flux or fusion mixture of Fresenius ($K_2CO_3+Na_2CO_3$) is quite adequate. In certain obstinate cases, however, it is advisable to use a little borax or potassium cyanide, or both, as well as fusion mixture. As the tin almost invariably, in the process of ordinary reduction on charcoal, separates out in rather small beads, which, because of their very fluid consistency at the temperature of the blowpipe flame, sink rapidly down through the flux, etc., to the bottom of the assay, or even a little distance into the support, it is necessary to cut out the ignited residue with some of the surrounding carbon on each side and below it, and transfer the whole to a mortar, where, after the operations, first of heavy and firm grinding to reduce the mixture to a fine, powdery condition, and then of washing or lixiviating with water in order to remove everything of a non-metallic nature, have been gone through, the silver-like malleable scales of the metal will be observed mainly adhering to the bottom of the mortar, but in part also to the pounding extremity of the pestle.

To prove that these silvery scales are tin, throw over them, in the mortar, two or three drops of boiling concentrated hydrochloric acid, and then add, by means of a glass tube, one drop of a fairly strong water solution of gold chloride and swing the mixture of liquids all round the bottom of the mortar for about a minute. If the white metallic scales originally observed were composed wholly or partially of tin, then by the treatment described, the bottom of the white porcelain or earthenware mortar will receive a distinct purple stain by the formation of the well known characteristic purple of Cassius. To further confirm the presence of tin, allow a current of sulphureted hydrogen gas to impinge for a very short time on the moist stained bottom of the mortar. The formation of a skin of brown stannous sulphide, arising from this action, will afford valuable additional and sufficient confirmation of the presence of the metal.—*Chem. News.*

DRUM FISH OF MAURITIUS.

AT a recent meeting of the Physiological Society, Berlin, Prof. Moebius spoke on a "drumming" fish (*Balistes aculeatus*) from Mauritius. During a recent visit to this island he observed a bright blue-colored fish in the shallow waters of the harbor; when caught and held in the hand this fish emitted from its interior a most striking noise, like that of a drum. A careful examination of the animal failed to reveal any obvious movements, with the exception of one part of the skin, lying just behind the gill slit, which was in continuous vibration. Notwithstanding prolonged endeavors, he had not been able to secure a second living example of this fish, and had hence been able to carry out his investigations on the cause of the drumming noise only on dead specimens. The portion of the skin (membrana supra-axillaris) which vibrates stretches from the clavicle to the branchial arch; it is provided with four large bony plates, and lies over the swim bladder, which in this fish for the most part projects out of the trunk muscles. Behind the clavicle lies a curiously shaped long bone, which is attached to the clavicle at one point in such a way as to form a lever with two arms.

The long arm of this bony lever (os post-claviculare) is embedded in the ventral trunk muscles, and is capable of easy movement to and fro. The short arm slides during this movement over the rough inner side of the clavicle, and gives rise to a crackling noise, and this noise is then intensified by the swim bladder, which lies in close proximity to the short arm of the lever and acts as a resonator. When the trunk muscles contract the body cavity is diminished in size, the air in the swim bladder is driven forward, and the bladder then communicates the vibrations of the bony lever to the membrana supra-axillaris, and the latter communicates them to the air.

The speaker was of opinion that the above was the explanation of the "drumming" of this fish; he was, at all events, unable to find any other organ in it which could account for the noise. This noise is not known to be emitted by other species of Balistes, although it is known to occur in other groups.

THE
Scientific American Supplement.

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